THE AMERICAN GAS LIGHT JOURNAL

PUBLISHED WEEKLY, AT No. 42 PINE STREET.

VOLUME XCVIII., No. 11.
Whole No. 1,971.

NEW YORK, MONDAY, MARCH 17, 1913.

Subscription, $3 Per Year.
$4 Canada, $5 Foreign.

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Riter-Conley Manufacturing Company

STEEL CONSTRUCTION

Pittsburgh

LIBRARY OF CONGRESS,
MAR 18 1913
SMITHSONIAN DEPOSIT.

GAS OVENS VS. VERTICAL RETORTS.

Berlin, Germany.

We are building a battery of Koppers horizontal Cross Regenerative Gas Ovens for the Berlin Gas Company.

Isn't that the place where they are supposed to have Dessau Verticals in their highest state of perfection?

It surely is, but the "World do move," and the Berlin Gas Company is wide awake.

Birmingham, England.

Here they have horizontals, inclines, and two different types of continuous verticals; and we are building a battery of cross regenerative gas ovens with a guarantee to produce better carbonizing results than they have obtained on any of their different types of retorts.

They Will All Come To It.

See our Brochures Nos. 3 and 4.

H. KOPPERS COMPANY,

CONSTRUCTORS OF BY-PRODUCT COKE AND GAS OVENS,

5 S. Wabash Avenue, - - - - Chicago, Illinois.

THE AMERICAN GAS LIGHT JOURNAL

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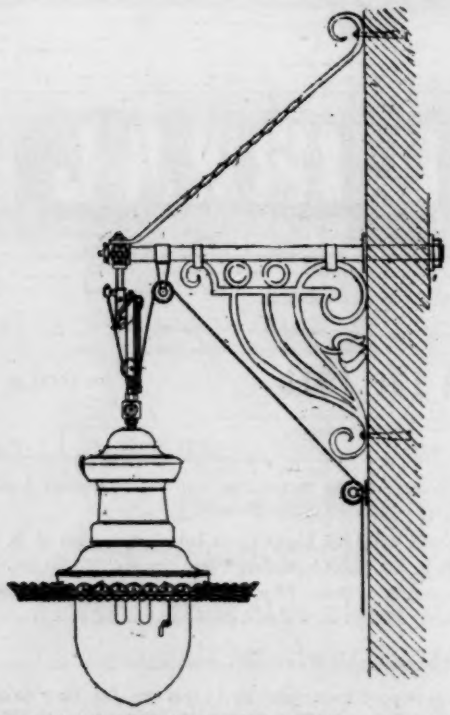
High Pressure Lamps for Advertising on Business Premises, with a Description of Suitable Raising and Lowering Gear for High Positions.[1]

In these days business is conducted at high pressure; and it is only consistent that, at any rate, the exterior artificial lighting of business premises should also be of the high pressure kind. We have had very cogent illustrations that this lighting system has become, on account of its multiple merits, a first favorite with the owners of business establishments. Some world-known business premises have adopted the lamps for advertising purposes. Sandow's cocoa establishment, for example. And now the Keith light has displaced mercury vapor lamps at the upper part of the extensive "Roneo" office furniture premises in Holborn. There five of the 1,500-candle power, high pressure lamps are fixed; being suspended from the top of the building in order to throw into relief at night time the front of the premises generally, and the name "Roneo" in particular. The lamps are situated between 60 and 70 feet from the pavement; and gas lighting from this position has been made possible by the use of Keith patent raising and lowering gear. The contract for the installation was secured by the Goswell Road branch of the Gas Light and Coke Company, and under its instructions the work was carried out by the James Keith and Blackman Company, Limited.

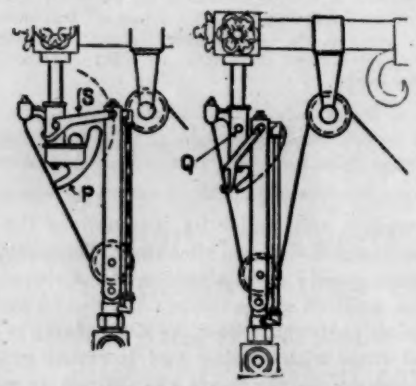
The photograph merely gives a section of the elevation of the building to show the position of the lamps; the second and third illustrations are sketches portraying how the Keith lamp is suspended from a bracket, and fitted with raising and lowering gear. These illustrations will perhaps convey more than words to our readers as to the method of fixing the raising and lowering gear from brackets. However, a few words of explanation may assist the illustration in elucidation. No flexible tubing is employed; but the arrangement permits a sound joint to be made while still allowing the lamp freedom to swing as on a ball joint. It is in reality a special form of cup-and-ball joint; the ball half being fixed to a hanger, and an inverted cup being fixed to a form of stirrup piece attached to the top of a lamp. The lamp is raised and lowered by a single winch; but as provision has to be made to enable the lamp to be raised and lowered without the use of the Keith traversing arrangement, this entails the addition of a pair of levers *S* to the stirrup piece. When the lamp is raised, the cup on the stirrup piece comes in contact with an inclined prong *P* on the lower part of the hanger, which pushes it out of the center as it is raised. On being raised above the prong,

Keith High Pressure Lamps Suspended from Brackets from the top of the Roneo Buildings.

1 *Journal Gas Lighting.*



Lamp on Bracket Fitted with Raising and Lowering Gear



An Enlarged View of the Gear.

the cup swings inwards to the center exactly over the ball; so that, upon being lowered, it will drop on the ball, and make a gas-tight joint by its own weight. To lower the lamp, it is first raised until the ends of the two levers engage with a pair of pins *Q* fixed on the hanger in such a way that, on again lowering the lamp, these levers cause the upper portion of the stirrup, with the cup, to describe a radial path which clears the prong. The ball half of the joint is fitted with an automatic ball valve, which closes by a spring as soon as the joint is broken, so that the lamp may be removed even if the high pressure is present up to the joint.

In the case of these lamps suspended from the top of the Roneo building, the winches are fixed in convenient positions inside the room opposite each lamp, so that a man can see the lamp connected and disconnected while he operates the winch. The lamps being 60 to 70 feet above ground level, this shows that to-day altitude is no obstacle to the use of high pressure gas lamps. As for the effect of the lighting, the photograph does not convey what is to be seen by a personal inspection of the lighting. The striking effect can, in reality, only be properly appreciated by inspection in the neighborhood.

[Official Report.—Continued from Page 148.]

FORTY-THIRD MEETING, NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

Held in Young's Hotel, Boston, Mass., Feb. 19 and 20.

First Day—Morning Session.

Committee on President's Address.

The Vice-President—Gentlemen, you have listened to an address that I think I can safely say, is the best of its kind. If the present incumbent in office should die in an attempt to do as well, please have engraved on his tombstone, "He did his ——dest." A motion is in order regarding your wishes.

On motion of Mr. Morrison the Vice-President was directed to appoint a committee to consider the points made in the address, the findings to be subsequently reported, and the Vice-President thereupon named as such Committee Messrs. Gould, Nute and Walter F. Norton.

The President assumed the Chair and asked for Reports of Committees.

Mr. C. A. Learned, from the Committee to prepare an obituary report over the death of Mr. E. C. Learned, submitted the following:

Everett Clinton Learned was born in Hartford, Conn., January 7th, 1843. His father was William Eli Learned and his mother was Caroline Havens, of Hartford. When a young man he moved to Springfield with his family, and during the war worked in the Armory in that city. Later he entered the employ of the Springfield Gas Light Company, but after a short time settled in Lee, Mass., as a member of the firm of Learned & Durant, steam and gas fitters and dealers in steam and gas pipe, etc.

In the year 1869 he came to New Britain to become Superintendent of the Gas Light Company. This position he held for 34 years, until 1903. After that time, on account of poor health, he did not engage in active business. He was well known to our older members. He joined this Association in 1872, one year after its organization.

He died March 18th, 1912. Mr. Learned married (in 1866) Fanny Moore of Lee, who died in 1903. A daughter survives.

C. A. Learned,
J. Arnold Norcross. } Committee.

The Secretary thereupon read the following report on the death of Henry F. Coggeshall, Fitchburg, Mass.:

The deceased was one of Fitchburg's best known citizens, and a man actively identified with the business development of the city. As a well equipped purchaser of real estate, he was exceeded by no other investor of Fitchburg, and the prosperity of this city is traceable to his method. Among his notable gifts to the city is the Coggeshall Park. In 1906 he gave $10,000 for a building for the Y. M. C. A. For 60 years he was the head of the Calvinistic Congregational Church. In 1871 he joined the New England Association of Gas Engineers, and the American Gas Light Association in 1874. He was a frequent attendant at our meetings, and contributed two papers to the New England Association. Henry F. Coggeshall was born in Mansfield, Conn., December 26th, 1823, and died December 15th, 1912. In 1853 he became connected with the Fitchburg Gas Light Company, and was its Treasurer until January, 1909, when the Tenney Syndicate assumed control of the Company. Mr. Coggeshall's sagacious management made the Company one of the most successful business corporations in the city. We can all testify to the personality of Mr. Coggeshall. His ways were those of probity, his practices were concomitant with gentleness, and his principles were ever under the dominion of the Golden Rule.

C. F. Spaulding,
W. A. Learned. } Committee.

Next came the report of the committee on the death of Cyrus M. Coburn:

Cyrus M. Coburn was born at Brunswick, Me., March 31, 1845. He died at Chelsea, Mass., August 16, 1912 He was elected to Associate Membership in 1889. While never directly engaged in the gas business, his association with it was of value to our members. His good business ability and sense of honesty led him well through his successful career. He was a man of strong convictions and quick to express them, but his friendship was loyal and lasting. We shall greatly miss his genial presence at our gatherings.

Resolved: That we extend to his family our deepest sympathy in their great loss.

Harry A. Norton,
Benj. J. Allen, } Committee.

Report of Committee on death of Eugene H. Yorke:

Eugene H. Yorke, General Manager of the Portland (Me.) Gas Light Company, died at his home on February 18th, 1912, aged 57 years, 3 months and 12 days.

Mr. Yorke, when a young man, had charge of the gas plants at Eastport and Calais, Me. In May, 1879, he accepted the position of Superintendent of the Lynn (Mass.) Gas Company. Later he engaged in the business of Consulting Engineer and rebuilt the gas

works at Eastport, Bangor and Augusta. In 1888 he took charge of the Brockton (Mass,) Gas Company, and in 1897 was elected Superintendent of the Portland (Me.) Gas Company, which he managed successfully until his death.

Mr. Yorke was a member of the American Gas Institute, of the Guild of Gas Managers and much respected member of our own Association.

The Association extends to his family its heartfelt sympathy.

WALTER G AFRICA, CHAS. F. PRICHARD, } Committee.

On motion, the reports were ordered incorporated in the Proceedings and the Secretary was instucted to send copies to the respective families. Next came the

REPORTS OF THE SECRETARY AND TREASRUER.

As Secretary Mr. N. W. Gifford said:

At the 42d Annual Meeting of the New England Association of Gas Engineers (held in 1912) there were elected 9 active members and 3 associate members. The resignations of 2 active and 3 associate members have been accepted. During the year there were lost by death 5 active and 2 associate members, leaving at the close of the year 5 honorary, 138 active and 96 associate members; or total 239 members.

During the year the Reports of the 41st and 42d Annual Meetings were printed in 1 volume and distributed to the members. The Library has been continued in Room No. 715, Tremont Temple. During the year 5 cases of books have been received from Mr. A.B. Slater. Additional cases have been secured and the books have been placed therein and some attempt has been made in arranging them according to subject matter. It is hoped thatmaterial when listed and catalogued will be more available. Another addition of 9 volumes relating to chemical work was received from Mr. Frederick Egner, who gave the original volumes which formed the nucleus of the Library. A few books have disappeared from the Library and it is hoped if members have borrowed them they will send them back.

An attendant is at the Library during business hours, so that some assistance may be had in finding books.

Respectfully submitted,

N. W. GIFFORD, Secretary.

READING THE CORRESPONDENCE.

As Treasurer Mr. Gifford reported the receipt of $1,956 77, an expenditure of $1,339.50, a balance of $517.27, and a total balance of $935.83. The report bore the attesting signatures of the Auditing Committee.

The Secretary—There is here quite a large bunch of correspondence, most of the letters being acceptances, but there are some few regrets. The one from Mr. Egner I will read, for he has been here a great many times and has done considerable for the Association, in the way of donations to the library, etc. His letter is:

Dear Mr. Gifford: A couple of weeks ago I contracted—no doubt in the unsanitary street cars of Washington, D. C—an attack of the genuine *la grippe*, which made me feel almost like giving up for all. Am now over it, but feel that I ought not risk the trip to Boston next week under the circumatances, as I still am a bit shaky. So to-day I send you, for the library of your Association, a few more books, per Adams Express, to your office, instead of coming. The books are: "Watts' Dictionary of Chemistry," by Morley & Muir. Four volumes. Do not confound these books as being the same as the other "Watts" which I sent you several years ago (9 volumes). It is a different work, and beginning to be rare, though, up-to-date, the same as the former was and still is. That, too, can hardly be found on sale now. I have tried and could not get it a couple of years ago.

I think you now have the best reference books on Chemistry obtainable in the English language. Then there is "The Gas Engine," by Forrest R. Jones; 1 volume. It is of the 1907 edition, hence pretty close up to date now. I want to call your special attention to a little paper-covered book, "Fuel Gas at Cincinnati," by General Andrew Hickenlooper. This was given or sent me by the General himself. I valued it more highly than any other book I had, not only because of the giver, but because it has ideas and analyses which make it extremely valuable (in my opinion) and I would not have parted with it, but for the evidence I had 2 weeks ago how very short my time sometimes seems to be, and how frail our existence is, under certain conditions. Not to blow or impress you with the value of the books I had the great pleasure to send you for your library in the past, but really because a mere little paper.covered book like that might easily be considered of no value at all, and thrown in the waste basket, I assure you I would not have traded that little book for "King's Treatise on Coal Gas," or any of the others which I sent you before or now. It ought to be taken good care of, for it may come in very handy for some of you one of these days. It is choke full of good thought for gas companies who may have to meet some damfool opposition cranks.

There are a couple of other paper-covered books worth keeping, but I will not go into detail about them. I hope you all will have a very good meeting. Please remember me to Mr. Coffin and Mr. Waldo Learned in particular. I hope to see you all at Richmond, Va., in October. Yours sincerely always,

FREDERIC EGNER.

I have another from a member who says that he has an uncompleted contract on hand which is about to materialize and cannot come. The others I think perhaps might be considered read by name.

A list of members from whom letters were received by the Secretary is as follows: G. W. Parker, Arthur Hewitt, J. D. Shattuck, D. R. Daly, D. R. Russell, A. C. M. Azoy, H. C. Adams, F. Egner, Jno. Williamson, W. M. Crane, J. S. DeHart, J. B. Klumpp, J. T. Lynn, and Henry C. Wharton.

A VOTE OF THANKS.

Mr. Crafts moved a vote of thanks to Mr. Egner for his donation, the account of the action to be conveyed to Mr. Egner by the Secretary. [Seconded.]

The President—It is moved and seconded that we extend a vote of thanks, and that the Secretary send notice of such vote to Mr. Egner for his donation to the Library. All in favor say "Aye"; contrary minded. It is a vote. [Adopted.]

The Secretary—If I might ask for instructions, I would suggest that perhaps either by this or by a separate motion, the quite extensive and very valuable donation of books from Mr. Slater be recognized. They are really a very valuable set of books.

Mr. C. A. Learned moved that the Association extend a vote of thanks to Mr. Slater for his donation. [Seconded.]

The President—It is moved and seconded that the Association extend a vote of thanks to Mr. Slater for his donation. All in favor of that motion say "Aye"; contrary minded. It is a vote. Now we are ready to have the

REPORT OF COMMITTEE ON NOMINATIONS.

Mr. Africa—Mr. President and Gentlemen: The Committee regretted that the President has declined to accept a nomination for a second year, so that it entailed furnishing a new list. We, therefore, report as follows:

For President—T. H. Hintze.

" *First Vice-President*—C. A. Learned.

" *Second Vice-President*—H. K. Morrison.

" *Directors*—J. F. Wing, H. C. Crafts, J. A. Norcross, A. M. Barnes and Carroll Miller.

For Secretary and Treasurer—N. W. Gifford.

Respectfully submitted,

W. G. AFRICA, W. H. SNOW, G. H. SCRANTON. } Committee.

ELECTION OF OFFICERS.

The President—You have heard the report of the Nominating Committee. What is your pleasure regarding the matter?

On motion of Mr. Prichard (seconded) the report was accepted and the Secretary was instructed to cast the ballot of the Association in favor of the election to office of the gentlemen named by the Committee. Subsequently the Secretary reported that the instruction had been carried out, and the President called upon Mr. Hintze to say a word or two to them in his capacity as President-elect.

The President-elect—I thank you, gentlemen, for the honor; and I can only say that I will do my best. New England, gentlemen, is the front yard of this country. New England gas men are prominent in that front yard, and I consider it a great honor to sit with them in Council. I thank you. [Applause.]

The President—Mr. Learned, we would like to hear from our new Vice-President.

Mr. Learned—I simply wish to extend my thanks to the Association for the honor conferred.

IN RESPECT OF THE PANAMA GAS CONGRESS.

The President—There is one matter of new business. The Association has been requested to appoint a delegate to be a member of the

Committee on Gas Congress, to be held at the time of the Panama-Pacific Universal Exposition, in San Francisco, 1915. Nominations for that Committee are in order.

Mr. Learned—Mr. President, I wish to name, as the member of that committee, Mr. Charles H. Nettleton, of New Haven.

The President—Are there any other nominations? A motion that the nomination be accepted and that Mr. Nettleton be appointed the member of the Committee is in order.

It was moved and seconded that the Secretary cast the ballot for Mr. Nettleton as the member of the Committee, which instruction was carried out, and Mr. Nettleton's election declared.

The President—We also have an invitation from the Panama-Pacific Universal Exposition to hold our annual meeting in San Francisco, in 1915. According to our by-laws we have to hold the meeting here, unless it is voted otherwise by the Association. There is no action necessary unless you wish to hold the annual meeting in San Francisco. If there is nothing done, we hold the annual meeting here as usual. Anybody who wishes that the annual meeting be held in San Francisco can make the motion, and it can be voted upon. As there is no motion, I take it that the meeting will be held here as usual, according to the by-laws, in 1915.

Greeting the Gloucester Man.

The Secretary—Mr. President and Gentlemen: One member whom we usually see here, Mr. Coffin, of Gloucester, is rather seriously sick, although he was reported then better, but he is liable to be laid up for quite a number of days, if not weeks. Some of the members have suggested that perhaps it might be well to send him some greeting from the meeting. As Mr. Coffin and Mr. W. A. Learned were the two men always specially sought out by Mr. Egner, I would move you, Mr. President, that Mr. W. A. Learned be instructed to send a message of cheer to our friend Mr. Coffin in Gloucester. [Seconded and adopted.]

Mr. Prichard—Mr. President, in glancing at this invitation it seems to me that we ought to acknowledge it, so I would move that the Secretary be instructed to acknowledge the invitation to hold our meeting on the Pacific Coast, sending our regrets that it is impracticable to hold the meeting in San Fracisco. [Seconded, put and declared adopted.]

The President—The motion is made and seconded that the Secretary acknowledge the kind invitation, but for various reasons which he will explain we will not hold the meeting otherwise than has been the custom. All in favor say "Aye"; contrary minded. It is a vote. That ends the formal routine business. If anybody has any new business to bring forward now is the time. If there is no further new business we will proceed with the programme of lecture and papers.

The President then introduced Albert F. Ganz, M.E., Prof. Electrical Engineering, Stevens Institute Technology, Hoboken, N. J., who delivered the following lecture on

ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS.

Definition and Theory of Electrolysis.—Electric current may be conducted in two ways: First, by metallic conduction; and, second, by electrolytic conduction. Metallic conduction occurs when an electric current passes through a metal, and is characterized by the fact that no chemical change is produced in the conductor, the only effect being the production of heat. When electric currents, therefore, pass through metallic conductors, such as copper wires, rails, or pipes, they prodnce no change in these conductors except to raise their temperature. Under all ordinary conditions stray electric currents found on underground pipes are not sufficiently large to appreciably heat these pipes. Under abnormal conditions pipes may, however, carry stray currents of sufficient magnitude to produce heating at moderately high resistance joints.

Electrolytic conduction occurs when an electric current passes through an electrolyte, and is characterized by the fact that the electric current is transmitted by a corresponding transter of *ions* in solution, with the production of chemical decomposition at the electrodes where the current enters and leaves the electrolyte. Electrolysis may, therefore, be defined as chemical decomposition produced by an electric current. Electrolysis is usefully applied in the arts for the refining of metals and for producing chemical compounds. The writer wants to discuss here the destruction of underground structures caused by electrolysis from stray electric currents which reach these structures.

Chemical compounds, in solutions of water, constitute the ordinary electrolytic conductors. Pure water itself has such a high resistance that it may practically be considered a non-conductor. It is for this reason that an iron pipe full of ordinary city supply water does not have a lower resistance than the same pipe without water. Water is, however, readily made conducting by the addition of small amounts of salts, and conduction through water is, therefore, always electrolytic.

The following is a brief explanation of the theory of electrolytic conduction. When a salt is dissolved in water, some of the molecules separate or dissociate into two parts, one part having a positive electrical charge, and the other a negative electrical charge, and these parts are called *ions*. The metal parts (or the hydrogen) constitute the positive ions, and the acid parts the negative ions. For instance, copper sulphate, $CuSO_4$, when dissolved in water, dissociates into the positive metal ion Cu and the negative acid ion SO_4. An electric current is transmitted through an electrolyte by the transfer of these ions. The electrode by which the current enters the electrolyte is called the *anode*, and the one by which the current leaves is called the *cathode*. The metal or hydrogen (positive) ions travel in the direction of the current and carry positive electrical charges to the cathode, and these metal ions, called cations, are deposited upon or are liberated at the cathode. The acid (negative) ions travel against the current and carry negative electrical charges to the anode, and these acid ions, called anions, will corrode the anode if it is a metal which combines chemically with these anions. The cathode is not corroded. With an electrolyte of copper sulphate dissolved in water, a copper anode corrodes into copper sulphate and dissolves, while metallic copper is deposited upon the cathode. If the electrolyte is common salt dissolved in water, the anions are chlorine, and an iron anode would be corroded, the iron forming ferrous chloride; the cations are sodium, and these would decompose the water present and liberate hydrogen at the cathode. These examples furnish an illustration of the fact that the corrosive action of the current results in supplying the electrolyte with an equivalent of the amount of salt decomposed by the current, so that the electrolyte is continually replenished with salt and its electrolytic conducting power is thereby maintained. This salt will contain metal ions of the anode or hydrogen, and may be different from the original salt which started the action.

Street soils, when entirely dry, do not conduct electric currents. Under ordinary conditions, however, street soils contain considerable water with salts in solution, generally chlorides, and this makes them electrolytic conductors. When an electric current passes through soil it, therefore, does so by electrolytic conduction and by corresponding chemical decomposition at the electrodes. Where an electric current leaves an iron pipe for soil it corrodes the iron by this action of electrolysis. It has been claimed in the past that soils may conduct metallically; but this has been disproved, and it is now recognized that conduction of electric current through soil is always electrolytic.

The rate at which ions are liberated at the electrodes is proportional to the current strength. With an oxidizing anode, such as iron or lead, the mass of anode corroded by one ampere in 1 second is equal to the electro-chemical equivalent of the metal of the anode. This is 0.00029 gram for iron (ferrous). From this the mass of iron corroded by 1 ampere in 1 year is $0.00029 \times 60 \times 60 \times 24 \times 365 \times 0.002205 =$ 20 pounds (approximately). The electrochemical equivalent for lead is 0.0010716 gram, and the mass of lead corroded by 1 ampere in 1 year is $0.0010716 \times 60 \times 60 \times 24 \times 365 \times 0.002205 = 74$ pounds (approximately).

The separation of the metal or hydrogen ion from the electrolyte in the cathode absorbs energy from the electric circuit, and generally produces an electromotive force in the opposite direction to the current. The oxidation of the anode supplies energy to the circuit, generally producing an electromotive force in the direction of the current. If the oxidizing anode is of the same metal that is being deposited upon the cathode, and if the electrolyte is the same at the anode and cathode, then there is no resultant electromotive force due to the electrochemical actions, and the only electromotive force consumed is that due to the resistance of the electrolyte in accordance with Ohm's law, exactly as with a metallic conductor. If the metal deposited at the cathode is different from that oxidized at the anode, or if hydrogen is liberated at the cathode, or if the electrolyte at the cathode is not of the same composition or density as at the anode, then there will be a resultant electromotive force, which may be either in the same or in the opposite direction as the current. It has been assumed by some writers in the past that no corrosion from electrolysis can take place

if the voltage between two metallic conductors in soil, such as between pipe and rails, is less than 1.5 volts, because this is the dissociation voltage of water. This, however, is entirely wrong, and it has been proven by many investigations, also by practical experience, that the amount of corrosion produced by electrolysis is independent of the voltage, except in so far as this determines the amount of current flowing, and that the smallest fraction of a volt can produce corrosion from electrolysis under suitable conditions, and this is now generally recognized by electrical engineers.

A large number of laboratory tests have been made to determine whether electrolysis is produced when an alternating current flows from a metal to an electrolyte; for example, from a pipe to surrounding soil. These experiments indicate that a slight amount of electrolysis may be produced by an alternating current, which is generally less than 1 per cent. of the amount of electrolysis produced by a corresponding direct current. It must be remembered, however, that, in the case of alternating current, electrolysis would be produced wherever there is a flow of alternating current between a metal and soil, while with direct current metallic anodes exist only at ½ the points where current flows between metal and electrolyte; namely, where current leaves the metal.

Sources of Stray Electric Currents.—Stray currents are electric currents which have leaked from grounded electrical distribution systems and flow through ground and through underground structures. Grounded telephone and telegraph lines produce electric currents through ground of such very small magnitudes that their effects upon underground piping systems can be neglected. Direct current, electric lighting systems, in which the distribution is on the Edison 3-wire plan, with the neutral conductor grounded, are in American practice provided with such large neutral conductors of copper that practically no stray currents are produced from such systems. This grounding of the neutral in Edison 3-wire systems is to serve as a safety measure, and is not for the purpose of using the ground to carry current.

The secondaries of transformers are also frequently grounded to underground pipes for the purpose of preventing a high and dangerous voltage from existing between the secondary circuit and ground. Such ground connections, however, do not produce flow of current from pipes to ground and, therefore, such grounding of transformer secondaries does not cause danger from electrolysis.

Electric railways, using the running tracks for return conductors, often produce comparatively large stray electric currents through ground, and these are the only sources of stray currents which need be considered in practice. Direct current is very generally used for such electric railways, and it is the common practice to supply current to the care from an overhead trolley wire or from a third rail, and to return this current to the power station through the running tracks, supplemented where necessary by return feeders. A single-trolley electric railway is shown diagrammatically in Fig. 1, in which the path of the electric current, from the positive terminal of the generator through the circuit and back to the negative terminal, is shown. The running tracks consist of rail lengths about 30 feet long, and these are mechanically fastened together by fishplates which consist of steel plates bridging across the rail ends and bolted to both rails. Such fishplates, while mechanically fastening the rail lengths together, do not form good electrically conducting connections between the successive rail lengths. For this reason, copper wires or straps, called rail bonds, are generally used to bridge across the abutting ends of the rail lengths for the purpose of affording a good electrically conducting path between successive rail lengths. The two rails of a single-track road, or the four rails of a double-track road, are also generally connected together at frequent intervals by cross bonds so that the 2 or the 4 rails may be available for the return of current. Instead of using copper rail bonds, the rail ends are sometimes welded together, or soft steel plates are welded across each side of the abutting rail ends, thus forming both a strong mechanical and a good electrically conducting connection between the successive rail lengths. A well bonded railway track should have a conductivity not less than 80 per cent. of the equivalent conductivity of continuous rails. To give some idea of the relative conductivity of steel rails, it may be stated that a single rail, weighing 90 pounds per yard, which is a size commonly used where the traffic is heavy, has about the same conductivity as a copper wire 1 inch in diameter. Thus the 2 rails of a single-track line, or the 4 rails of a double-track line, laid with 90-pound rails and well bonded, afford a good conducting path for electric current.

In the simplest form of single-trolley railway, already shown in Fig. 1, the rails are connected to the negative terminal of the generator

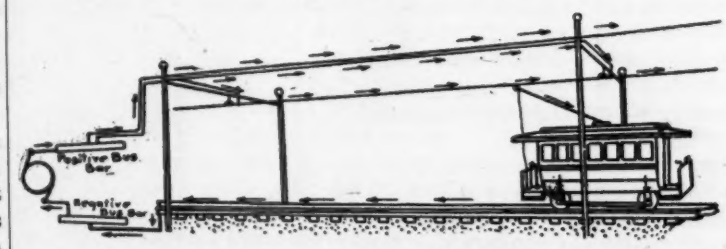


Fig. 1.—Diagram of Single-Trolley Electric Railway Showing Path of Current from Generator Through Positive Feeders, Trolley Wire, Car and Rails.

at the power station, and the only path for current to return to the power station is by way of the running tracks. If the running tracks are laid upon wooden ties above ground, with broken stone for road ballast, as is common on steam railroads which run on their own right-of-way, the rails do not come in direct contact with ground, and the return current will be practically confined to the running tracks. If, however, the running tracks are laid below ground so that the top of the rails is on the level of the surface of the street, as is common in cities, then the rails will be exposed for a considerable area to contact with soil. If the tracks are laid on a concrete base a considerable area of the rails will similarly be in contact with the concrete. Since both damp soil and damp concrete are under ordinary conditions conductors of electricity, part of the current returning through the rails will shunt from the rails through the surrounding soil, as is illustrated diagramatically in Fig. 2. It will be seen that, with the usual connection of positive terminal of the generator to the trolley wire and the negative terminal to the rails near the power station, the current will leave the rails for ground at points distant from the power station, and return to the rails in the neighborhood of the power station, in its path back to the negative terminal of the generator. Since every electric circuit must be completely closed, all current escaping through ground must again leave ground to return

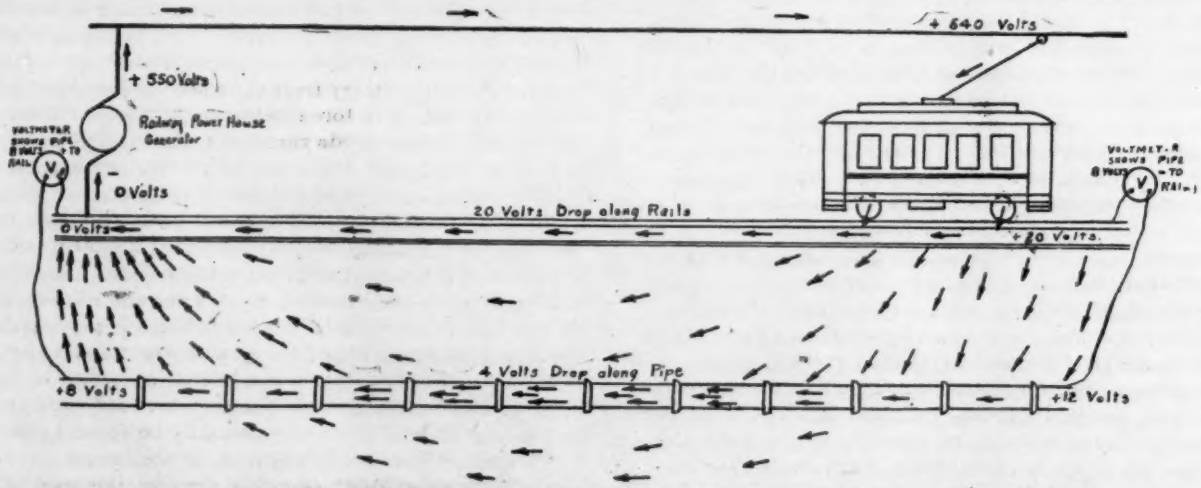


Fig. 2.—Diagram Showing Stray Railway Currents with Assumed Distribution of Potentials Caused by These Currents.

to the dynamo so as to complete the electric circuit. Where underground metallic structures, such as gas or water pipes, lie in ground in the path of these stray currents, and where these pipes have electrically conducting joints, such as lead-calked joints or screw coupling joints, current will flow from ground to such pipes and flow largely on such pipes in a direction towards the power station. In the neighborhood of the power station this current will leave the pipes to return to the negative terminal of the generator, as shown in Fig. 2.

In the negative terminal of the generator or negative bus-bar is connected to the rails, at points some distant from the power station by means of insulated negative return feeders, then, at such connection points, the rails will be rendered negative in potential to ground, and currents will tend to flow from underground pipes through ground to return to the rails in the neighborhood of these connections. Stray railway currents on pipes will, therefore, tend to leave these pipes to return to the rails in all regions where these rails are connected to return feeders.

It must be noted that, while ordinary soil is a conductor of electricity, compared with metals its electrical resistance is enormously high; for instance, the resistance between the opposite faces of a foot cube of ordinary soil may measure anywhere from 10 to 1,000 ohms, depending upon the amount of moisture and the amount of salts in the soil, while the resistance of a foot cube of iron is equal to about 0.0000004 ohms; if, therefore, we take an average value of 100 ohms for the resistance of a foot cube of soil, it is seen that soil has no resistance which is of the order of 250,000,000 times as great as a body of iron of the same dimensions; that is to say, the conductivity of iron is 250,000,000 times as good as ordinary soil. It would seem from this that current would flow almost entirely on the good conducting rails and none through the high resistance ground. Resistance, however, varies directly as the length and inversely as the cross-section of a conductor, and with the large surface of rails exposed to the ground, the cross section of the path of the current through ground is enormously great compared with the cross-section of the path of the current through the rails. As a matter of practice it is found that where the rails alone are used for the return of current, frequently a considerable portion of the total current actually leaks from rails through ground.

From the above considerations it will be seen that the leaking of current from the rails of electric railways, producing stray currents through ground and on underground piping, does not constitute a source of loss to the railway company; as, for instance, would be the case with leakage of gas or water. On the contrary, by allowing the current to return by ground and underground pipes as well as by way of the rails, the total conductivity of the return circuit is increased, and the voltage loss in the return of this current is decreased, so that there is an actual saving of power for the railway company.

During the last few years alternating current has also been used in a number of cases for electric railways which employ the running tracks as a return conductor. Where these rails are in contact with ground stray alternating currents through ground are undoubtedly produced. As already pointed out, such alternating currents may produce electrolysis which varies up to 1 per cent. of that which would be produced by a corresponding direct current. However, no actual case of electrolysis from alternating currents from such railways has been reported, as far as the writer is aware. This may be due to the fact that alternating current electric railways in nearly all cases operate on long distance lines and on their own right-of-way, where they are away from underground piping networks. The author, therefore, does not feel warranted in drawing any positive conclusion as to the possible danger from electrolysis caused by alternating current electric railways where they operate within city limits.

General Effects of Stray Electric Currents on Underground Piping.—The current flowing through the rails from the trolley cars back to the power station produces in these rails a drop in potential; that is to say, points in the rails away from the power station have a positive potential with reference to the rails at the power station. Since potentials are measured relatively it is convenient to consider the negative terminal of the dynamo, which is assumed connected to the rails at the power station, as at zero potential. The distribution of potentials in the rails of a simple electric railway system, and in the underground piping, is illustrated in Fig. 2, in which convenient values have been assumed. It will be noted that the stray current causes the underground pipes to be negative to the rails at points away from the power station, and positive to the rails near the power station. It is also seen that the negative potential of the pipe, plus the drop on the pipe, plus the positive potential of the pipe, equals the drop in the rails. In the case assumed a potential difference of 550 volts is maintained at the power station; of this, 10 volts is lost in the trolley wire, 520 volts is used by the motors of the cars, and 20 volts is left to bring the current back to the power station. If the negative bus-bar and the rails at the power station are considered as at zero potential, the rails at the car in the assumed case will have a potential of + 20 volts. Thus, for practical purposes, the ground with its underground pipes is subjected to a potential difference of 20 volts, and the amount of stray current produced is that due to these 20 volts. If the rails are laid in the usual way—that is, in contact with ground—the 20 volts in the rails will send some shunting current through the ground and through the underground pipe as shown in the diagram. Under the assumed conditions, there is a drop of 8 volts from the rails to the pipe near the car, a drop of 4 volts in the pipe itself, and a drop of 8 volts from the pipe through ground to the rails at the power station. It is, therefore, seen that it is the potential difference or drop in grounded rails caused by the return current which is the cause of stray currents through ground. Attempts should, therefore, be made to keep the potential difference or drop in rails as low as practicable, in order to keep stray currents through ground down to a minimum.

From the explanation of metallic and electrolytic conduction given in the first part of the paper, it will be understood that, where stray currents flow on underground pipes, they do no harm, except where they leave the pipes to flow to the surrounding soil. At such points corrosion of the iron from electrolysis will take place, and theoretically there will be a loss of 20 pounds of iron per year for every ampere of electric current leaving the iron. Some have assumed that, with the low densities at which current generally leaves underground pipes, little or no corrosion is produced. A number of experiments made by the writer have clearly shown, however, that, even when current leaves iron for street soil at an extremely low density, corrosion is produced which is at least equal to, and frequently greater than, the theoretical amount. This increase of the actual over the theoretical amount is undoubtedly due to secondary chemical reactions set up by the action of electrolysis.

The underground structures which are most likely to be subjected to destruction from electrolysis, caused by stray electric currents, are piping systems and lead cable systems. From what has been said above it will be seen that oxidation or corrosion of such pipes or cable sheaths will occur wherever current leaves the pipe or cable sheath for ground. In the simplest case, illustrated in Fig. 2, current flows from rails through ground to the pipes at points distant from the power station, flows along the pipes and leaves the pipes to return through ground to the rails in the neighborhood of the power station. Where the current flows from the rails to ground the rails will be corroded, and where the current flows from the pipes to ground the pipes will be corroded. If the pipe line is a uniform electrical conductor, and the relative arrangements are as shown in Fig. 2, then the pipes will be corroded only in the neighborhood of the power station. If, however, the pipe line is not a uniform conductor, as, for instance, if there are one or more high resistance joints in such pipe line, then the current on the pipe will shunt around these high resistance joints to produce oxidation or corrosion on one side of the joint. This action gives rise to joint corrosion, which is frequently found. Where there are two or more underground piping systems it also frequently happens that current shunts from one piping system to another through the intervening soil, producing electrolytic corrosion where the current leaves the pipe. Such shunting currents are often caused by accidental high resistance joints in one of the pipe lines, and such shunting may occur anywhere and without reference to the location of the railway power station. Where a direct-current trolley railway system passes through a town which has an independent piping network, and where the power station supplying the trolley line is in some other locality, then if stray electric currents are produced from the trolley line where it passes through the town, they will flow on the piping system, making this piping system positive to ground and to rails in the direction towards the railway power station and negative in the direction away from the railway power station. In this case electrolysis of the piping will be produced at the ends of the piping system towards the railway power station.

Where current leaves a wrought iron or steel pipe for ground, the oxide of iron resulting from electrolysis is diffused through the soil, and streaks of iron oxide can generally be found in the surrounding soil. Electrolysis of wrought iron or steel pipes usually results in pits, which eventually go entirely through the wall of the pipe. It

has frequently been found in practice in the case of gas pipes that where a service pipe lies in clay or other tightly packed soil, it may be pitted through in many places without giving any external sign of leakage, because the soil surrounding the pipe maintains it gas tight. When cast iron is corroded by electrolysis, the oxide of iron mixed with graphite usually remain in place leaving the outside appearance of the pipe unchanged. This material resulting from electrolysis of cast iron usually has the consistency of hard graphite, and can be cut with an ordinary knife. There have been many cases in which a cast iron main was carrying gas or water without any apparent leak, where a single blow with a hammer drove a hole right through the pipe. Here the electrolytic action had corroded the iron entirely through the pipe, and the oxide of iron had remained in place, and, together with the surrounding soil, had prevented the pipe from leaking. Whether or not the mixture of iron oxide and graphite resulting from electrolysis remains in place so as to maintain a pipe gas or water tight, depends upon the surrounding soil conditions. It is, therefore, seen that an underground piping system may be suffering severely from electrolysis without having given any outward sign of the damage. A physical examination with a test hammer is required in the case of cast iron piping to establish definitely whether or not it has been damaged by electrolysis.

For a given current leaving an iron pipe, there is practically no difference in the amount of iron destroyed between cast iron, wrought iron and steel. The electrical resistivity of cast iron is, however, about 10 times as great as that of wrought iron or steel, and the usual lead joints in cast iron pipes also have a resistance many times greater than the screw-coupling joints usual with wrought iron and steel pipes. For these reasons a given voltage drop through ground will cause a much smaller current to flow on a cast iron pipe than on a wrought iron or steel pipe, thus practically making cast iron pipes much less subject to electrolysis than wrought iron or steel pipes. The most frequent damage from electrolysis is found in the case of service pipes where these cross under trolley rails or other underground conductors to which they are positive. Examples of destruction of pipes by electrolysis which are often found in practice will be taken up in a later chapter under the heading of "Damage and Danger Produced by Stray Electric Currents on Underground Piping."

A number of investigations have been made to determine the effect of electrolysis on iron or steel embedded in concrete, and these have shown that where the iron is an anode—that is, where current passes from the iron to the concrete—this effect is to corrode the iron and form rust which occupies more space than the iron, causing expansion which finally cracks the concrete. The most recent and most complete investigation of this kind is one made at the Bureau of Standards, Washington, and described in a paper by E. B. Rosa, Burton McCollum and O. S. Peters, presented before the National Association of Cement Users in Pittsburgh, December, 1912. A comprehensive abstract of this paper is published in the "Engineering News," December 19, 1912. These recent experiments have shown that an extremely small current, flowing from an iron rod to a surrounding block of concrete, will produce enough corrosion to crack the concrete in the course of 1 or 2 years. These investigations have also shown that the presence of even a fraction of 1 per cent. of salt or of other chlorides may increase the action of electrolysis on iron embedded in concrete over 100 fold. They have also shown that, where the iron is a cathode—that is, where current passes from concrete to the iron—a softening of the concrete is produced in the immediate neighborhood of the iron which eventually destroys the bond between the concrete and the iron. The introduction in recent years, of buildings constructed entirely of reinforced concrete, has raised the question of the possible damage to such buildings from electrolysis of the reinforcing steel. Where reinforced concrete structures are located near railway power stations which have a grounded negative bus-bar, there may be a considerable potential gradient through the ground upon which the concrete building stands, and in such cases it is possible that currents may flow through such a reinforced concrete building. These currents, although very small in magnitude, may cause a great deal of damage because the successive elements of steel and concrete form a series circuit, and damage will result at every point where current flows from steel to concrete or from concrete to steel. The most likely means of entrance or exit of stray electric currents, into or out of such buildings, is by underground gas or water pipes, or by foundations of concrete or of steel. In the light of these recent investigations it would, therefore, seem a wise precaution in such buildings to install insulating joints in every pipe which connects to the building from ground. In the paper above referred to it is also suggested that granite blocks might be interposed between the building footings and soil so as to prevent stray currents from flowing into and out of the building through the footings.

Electrolysis Surveys.—The diagram illustrated in Fig. 2 shows that voltage drop in the rail produces stray current through ground and through underground pipes, and produces potential differences between pipe and rails, making the pipe appear positive in potential where current leaves the pipe, and negative in potential where current flows to the pipe. The first step in an electrolysis survey of a town is, therefore, to measure potential differences between pipes and rails, at a number of points throughout every street on which there are electric railways. Where the main itself is not exposed, connections to the pipes for these voltmeter measurements may be obtained by means of service pipe or drip connections. Such connections are generally satisfactory because the voltmeter itself has a high resistance and, therefore, takes only a very small current. Readings are taken at each point every 10 seconds for 10 or 20 minutes, depending upon the car schedules, and the maximum, minimum and average results of the readings recorded. A convenient instrument for these potential readings, which can also be used for the drop measurements described below, is a Weston, Model 1, combination millivoltmeter and voltmeter, with its zero in the center of the scale, and having ranges of 5, 50 and 500 millivolts and of 5 and 50 volts. These instruments are made with very high resistances, so as to be particularly applicable to electrolysis testing.

After such potential measurements have been made throughout the principal streets of a town, they are then conveniently plotted on a skeleton map of the town, in which the trolley lines are shown. The potentials of the pipes referred to the rails are laid off normal to the lines representing the railway tracks to some convenient scale, usually 1 inch = 10 volts. The ends of these potential lines are then connected, and the included areas are colored red where the pipes are positive in potential to the rails, and blue where the pipes are negative in potential. In Fig. 3 is shown a typical potential survey

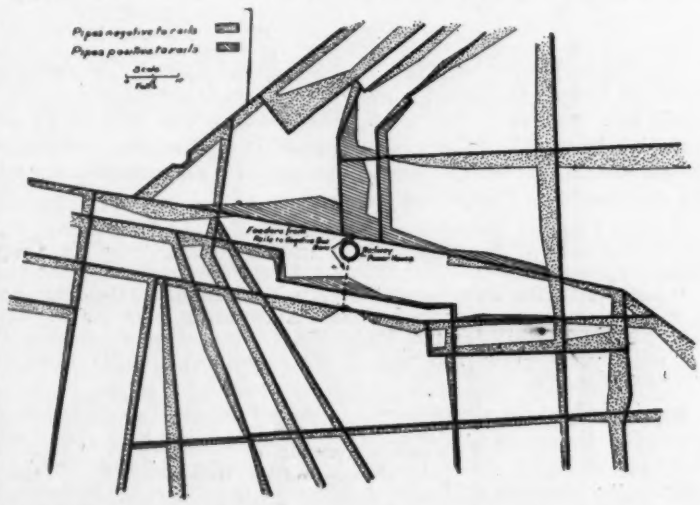


Fig. 3.—Typical Potential Survey Plotted on Skeleton Map of City Showing Electric Railway Tracks and Potentials of Underground Pipes Referred to Trolley Rails.

map, in which the negative areas are shown by dots, and the positive areas by section lines, instead of by blue and red areas. It will be noted that, in the neighborhood of the railway power station, the pipes are highly positive to the rails, and at points distant from this station they are negative to the rails. The existence of potential differences between pipes and rails is, however, no conclusive evidence of stray currents on the pipes; they indicate at what points current is probably flowing from rails to pipes and from pipes to rails.

Where there are a number of underground metallic structures which may be affected by electrolysis, it is desirable to make simultaneous measurements of potential difference between the rails and each of these structures. The average values of these simultaneous potential measurements may then be conveniently plotted on a diagram in which the potential of any one of the structures is taken as the datum or zero of potential. In Fig. 4 is shown a set of diagrams giving the relative potentials between water pipes, trolley rails and underground cable sheaths, at 3 points along a given street. In this diagram the water pipes are assumed as the datum or zero of poten-

(*Continued on page* 178.)

THE AMERICAN GAS LIGHT JOURNAL

Entered at the Post Office, New York City, as Second-Class Matter.

Published weekly at 42 Pine Street, New York City.

Telephone Call, John, 2996. Cable, Am-Gas.

A. M. CALLENDER & CO., - - Proprietors.

THOMAS J. CUNNINGHAM, ELBERT P. CALLENDER, } Editors.

CHARLES H. WADELTON, Manager.

Agents—American News Co., 11 Park Place, New York City.
Lemcke & Buechner, Berlin, Germany.
Aug. Siegle, 30 Lime Street, London, England.

TERMS OF SUBSCRIPTION.

United States, Cuba and Mexico, $3 per year. Canada, $4 per year. All other countries, $5 per year.
Single Copies, 10 Cents.

NOTICE TO ADVERTISERS.

New Advertisements and changes of copy therefor should be in hand Wednesday noon of week prior to date of issue.

NEW YORK, MONDAY, MARCH 17, 1913.

[Official Notice.]

Fifth Annual Meeting, Pennsylvania Gas Association.

Pennsylvania Gas Association,
Office of the Secretary,
West Chester, Pa., March 1, 1913.

The Fifth Annual Convention of the Pennsylvania Gas Association will be held at York, Pa., on Wednesday, Thursday and Friday, April 9th, 10th and 11th, 1913. The headquarters will be at the Colonial Hotel. The Committee requests a prompt reply on the inclosed postal, that reservation may be made for each member attending the meeting. The papers promised are:

"High Pressure Distribution," by Mr. C. M. Cole, Harrisburg, Pa.
"Valuations of Gas Companies for Rate Making," by Mr. Grier Hersh, York, Pa.
"Industrial Gas Appliances," by Mr. E. C. Romain, Reading, Pa.
"Gas Company Classification and Accounting," by Mr. J. Wittaker, Fernley, Philadelphia, Pa.
"Demonstration of the Use of the Pulmotor," by Mr. Conner, Philadelphia, Pa.

In addition to the above papers there will be the following list of topics for discussion: "Selling Campaigns," "Lighting and Heating Appliances," "House Piping," "Advertising," "Meeting Competition," "Methods of Handling Orders in the Office," "Methods of Handling Merchandise Orders, Office to Shop," "Educating Order Men," "Prepayment Meters," "Waste Heat Boilers," "Coal Gas," "Photometry and Calorimetry in Small Works," "Checking Work Done by Order Men."

Entertainment.

Wednesday Night.—Theater party.
Thursday.—Trip to Gettysburg battlefield as the guests of the York Gas Company.
Friday Night.—Informal dinner and smoker. Tickets for theater and dinner-smoker $5.

The members are requested to return postal card notice to Mr. Philbrick, at once, that, with your help thus rendered, the work of the Committee may be successfully carried out.

W. O. Lamson, Secretary.

[Special Editorial Correspondence, by Telegraph.]

FIFTH ANNUAL MEETING, INDIANA GAS ASSOCIATION.

Indianapolis, Ind., March 12, 1913.

The Hoosier Gas Association convened to-day at the Claypool Hotel, this city, for its fifth annual meeting. A splendidly representative gathering greeted the President, Mr. Howard L. Olds, as he assumed the speakers' chair shortly after 10 A.M. In reality this is the largest opening attendance the Association ever had. Governor Ralston the successor to Thomas R. Marshall, Vice-President of the United States, sent word at the very last hour that, owing to pressure of business connected with the doings of the Indiana Legislature, he was unable to be present. In reality the convention began with the meeting of the Executive Committee last evening, when the Board, amongst other clever determinings, gracefully recommended the election of Mr. William Wallace the reigning Vice-President, and one of the oldest members of the gas fraternity in Indiana (he has been actively in the gas business for 45 years), to Honorary Membership. The formal election by the Association was one of the happy features of its first morning session. The veteran gas man, who is Superintendent of the Indiana Lighting Company's plant at Lafayette, Ind., was present and feelingly acknowledged the honor. President Olds, in his excellent inaugural address, referred particularly to the Indiana Public Utilities law recently enacted, and advised the gas companies of the State to put their houses in order prior to May 1st, when the measure becomes operative.

The report of Secretary and Treasurer Eves, who is as precise and accurate as ever, reported an increase in membership of 13 for the year, which addition brings the total roll call to 149; pretty good showing for the hoosier gas men and positive proof of the harmony which governs the industry of that State. As Treasurer Mr. Eves reported "all bills paid, with a substantial balance in the bank."

This brought the programme to the paper list. The opening number was a paper by Mr. A. S. Cooke, of Terre Haute, whose clever recital of "The Benefits of Gas to the Public," had the real ring in that it showed in high degree that gas was still the standard medium for the production of illumination and heating for and to the public. Then came two valuable papers by Prof. Frank C. Mather, of the Indiana University. The titles thereof were respectively: "Preservation of Wood with Water Gas Tar," and "The Determination of Hydrogen, Nitrogen and Methane in Gas by Combustion in a Quartz Tube." The Professor accentuated his pleasant delivery by means of several well shown illustrations. The discussions were animated and widely participated in. At 2 P.M. the members journeyed from the Claypool in a body to inspect the splendid exhibit of industrial gas appliances so invitingly shown in the Indianapolis Gas Company's permanent gem of a showroom. The many forges, furnaces, ovens, hotel appliances, bakers' ovens, along with scores of other sorts of gas using apparatus, were nicely exhibited and intelligently demonstrated. The exhibit was brilliantly lighted by means of the new "Welsbach Reflex" No. 20, single mantle, commercial lamp. The concensus of opinion as determined from the expressions of the visitors rather goes to show that this high candle power unit will make it quite lively for the electrics of the tungsten, mazda or other type. In the evening a satisfying and well served banquet was attended by 175 members and guests. The jollification included songs, story narrating and merry speech making, all of which went to have the gathering one of the most pleasant and successful reunions in the history of the Association. Perhaps to Messrs. D. Moorehead and John F. Gilchrist should go the honors in respect to the after dinner speeches.—E.

Indianapolis, Ind., March 13, 1913.

The second day's session was commenced at 10:15 this morning with a good attendance. The first thing to engage the Association was a paper on "Motor Trucks," by Mr. Geo. M. Dolley, of Logansport. The discussion, which was animated and lengthy, was opened by Mr. Carl Graf, of the Indianapolis Gas Company, who gave statistics with much valuable information on operating costs and actual working of the trucks. Then came an interesting lecture by H. N. Tolles, of the Sheldon School, whose theme was "Fundamentals and Business Efficiency." The lecture was freely illustrated with lantern slides. The morning session ended in an ascension to the roof of the Claypool where a photograher speedily pictured the climbers. In the afternoon the first thing to occupy the attention of the body was the consideration of a paper by Mr. O. O. Thwing, Chief Engineer, Western Gas Construction Company, on the subject of "Workmen's Compensation." This paper was brimful of interest, and you may take it from me that its paragraphs are bound to have wide circulation amongst the industry.

The Bureau of Information, organized a year ago, has been splendidly supported as evidenced by the valuable information and data presented at this meeting. The various subjects dealt with in their

discussion took up 2 hours of time. The following officers were elected:

President.—Mr. A. S. Cooke, Terre Haute.
Vice-President.—Mr. A. C. Blinn, Evansville.
Secretary-Treasurer.—Mr. Philmer Eves, Indianapolis—Fifth consecutive year.
Directors.—Messrs. B. H. Danforth, J. H. Maxan, W. D. Ray, S. E. Mulholland and O. O. Thwing.

Terre Haute was chosen as next place of meeting. Communications were received from Mr. Walter R. Addicks, Chairman American Gas Institute, and from the President and Directors of the Pacific Coast Gas Association, regarding the Panama-Pacific Universal Exposition, were referred to the Executive Committee for consideration and action. From the tenor of the discussion respecting this matter, the fact is evident that the Association desires to give every active support to the 1915 gathering. In conclusion let me say that a delegation of ladies chaperoned by Mrs. O. N. Guldlin, ex-Chairwoman of the Home Economic Section, National Federation Women's Clubs, honored us with their presence. And let me further say if lusty cheering repaid them for their visit, they surely were paid in full. Our well beloved veteran, James W. Dunbar, declined to further serve on the Directorate, but we have his own good word that such action is far from meaning any weakening of his active interest in the affairs of the Association. The meeting was in all respects successful and the members are even now talking of next year's assembling.—E.

BRIEFLY TOLD.

THE MEETING OF THE BRITISH GAS INSTITUTE.—The British Institution of Gas Engineers will hold its Fiftieth anniversary, beginning June 17th next. The ever-genial and hospitable Sir Corbet Woodall is the President of the Institute at this time. As many of our readers may know, he is also the Governor of The Gas Light and Coke Company, of London, which is now a "good second" to the "Consolidated," of New York. Formerly and not so long ago The Gas Light and Coke Company was the leading gas company of the world, and in fact it would be to-day, but for the phenomenal growth of our own "Greater City." Gas men visiting Europe early the coming summer will have the opportunity to visit, not only the British Gas Institute, but the Fifty-fourth Annual Meeting of "The German Association of Gas and Water Engineers," which will be held, from Monday, June 23d, until and including the following Friday, at Strasburg, in Elsace. Visitors at the German city formerly (for many centuries) by virtue of conquest, a French city, will thus not only be able to be present at two great and always notable gas conventions, but to see a city famed in French and German annals for romance and beauty.—F. E.

AMERICAN ENGINEERS IN TOUR OF GERMANY.—The American Society of Mechanical Engineers have forwarded this circular, which is worth studying: "To foster a broader commercial spirit between America and Germany, about 200 of the most prominent mechanical engineers of the United States will go to Europe this summer to attend the 54th Annual Meeting of the 'Verein Deutscher Ingenieure,' in Leipzig, and to inspect the educational and industrial establishments of Germany. The party will sail June 10 on the Hamburg-American line steamship Victoria Luise, the largest and most superbly appointed cruising steamer afloat. Many friends of the engineers are also planning to sail on the steamer and will probably compose the entire passenger list. The official party will consist of 200 members of The American Society of Mechanical Engineers, accompanied by 100 ladies. The programme will include many features of interest. On arriving in Hamburg, on June 21, the great shipyards will be visited. The party will then proceed next day by special train to Leipzig. Here the King of Saxony will welcome the visitors and the Verein Deutscher Ingenieure will tender an official reception, at which the President of The American Society of Mechanical Engineers, Dr. W. F. M. Goss, Dean of the College of Engineering of the University of Illinois, will make the principal address. The party will leave June 25 for a tour of industrial Germany, visiting Dresden, Berlin, Cologne, Düsseldorf, Frankfurt, Heidelberg and Munich, including a trip up the Rhine. Independence Day will be celebrated at Frankfurt under the auspices of the American Embassy."

The Spring Meeting of the American Society of Mechanical Engineers will be held on May 20-23, in Baltimore, which, with its remarkable harbor and nearness to Washington and Annapolis, is a most attractive city in which to hold a convention.

CURRENT MENTION—

JUST as we go to press we have news of the sudden death of Dr. Frederick Schrieward, who passed away at his home in Englewood, N. J', the morning of the 12th inst. He was in his 52d year. The funeral service was held the afternoon of last Saturday.

THE Incorporations Committee of the Connecticut Legislature has reported favorably upon the bill increasing the capital stock of the Meriden (Conn.) Gas Light Company to $1,000,000, from $500,000. This, too, despite the strenuous objections of that rare gem of a reformer, Senator Neebe.

ELSEWHERE we note in our advertising columns that Messrs. Henry L. Doherty & Co., are offering at par and accrued interest to date of delivery, $3,500,000 one year, 6 per cent. convertible coupon gold notes of the Gas Securities Company, dated March, 10, 1913, and due March 10, 1914. The notes are convertible into preferred and common stocks of the Utilities Improvement Company on the basis of par for the preferred, with a "bonus" of 30 per cent. in common, if the privilege is exercised before May 10, 1913. All notes converted subsequent to that time will carry a less "bonus" of 1 per cent. for each month until the date of maturity. Subscriptions are payable 10 per cent. in cash on date of subscribing and the balance on allotment. Subscriptions will be received until noon, March 20, at the office of Henry L. Doherty & Co., 60 Wall street, New York. The Gas Securities Company, on December 31st last, had a surplus of $2,190,951; capital stock, $852,800, and total assets of $3,276,654. There have now been added to the assets $3,500,000 preferred and $1,750,000 common stock for the Utilities Improvement Company, which, at present market prices, are valued at $3,920,000, making the total present assets, $6,996,654. This is approximately twice the total issue of notes. The Utilities Improvement Company, as a result of the rearrangement of Doherty properties, has been placed in an unusually strong financial position. At the present time its total liquid assets, including stocks, bonds, cash, etc., amount to $29,374,081. Current earnings are at the rate of 5.18 per cent. on its common stock.

THE proprietors of the Clifton Springs (N. Y.) Sanatorium Company, have increased the selling rate to $1.50 from $1.25 per 1,000 cubic feet, the advance to become operative the 1st prox.

THE net earnings of the Fall River (Mass.) Gas Works Company in January last exceeded those of the corresponding month in 1912 in the sum of 3.9 per cent.

ACCORDING to a statement made last week by Messrs. N. W. Halsey & Co., of New York, the Pacific Gas and Electric Company has been awarded a contract for the supply of gas, electricity and steam for the time and period of the Panama-Pacific International Exposition Company. The cable announcing the contract is as follows: "Contract signed between Panama-Pacific International Exposition Company and Pacific Gas and Electric Company, under which the latter will supply exclusively during the next 3½ years all electric current required for power and lighting purposes during the term of the World's Fair in San Francisco in 1915, and during the period of construction and dismantling. Present estimates are that the Exposition will require 20,000-horse power. Gross amount of this business estimated at $500,000. Simultaneously contracts also made with Pacific Gas and Electric Company, for all gas and steam required by Exposition."

LAST week we noted that the Consumers Gas Co., of Reading, Pa., had announced a reduction to 90 cents per 1,000 cubic feet. The fact is, the gross rate was reduced to $1.10, with a discount of 10 cents, or a net rate of $1 per 1,000 to the ordinary consumer. With this reduction, the Company now operates a sliding scale of net rates as follows: $1, 90 cents, 80 cents, and 70 cents. Good work this, Mr. Keppelman.

THE people of Hightstown, N. J., are denied a supply of gas through the ruling of the New Jersey Public Utility Commission that the Public Service Corporation might not charge a higher rate (90 cents per 1,000) than that charged in Trenton, N. J., from whence Hightstown supply would be derived. The population of Hightstown is not sufficient to warrant the corporation piping the district.

(Continued from page 175.)

tial, and the potentials which are positive to the pipes are laid off above the axis, while those which are negative to the pipes are laid off below the axis, to the scale indicated in the diagram. In the case shown in Fig. 4, the cable sheaths are connected to the railway return conductors near the railway power station. It will be noted that, at the point nearest the power station, the water pipes are positive both to the cable sheaths and to the rails, and that the cable sheaths are also slightly positive to the rails. At greater distances from the power station the rails become increasingly positive to the water pipes, while the cable sheaths become increasingly negative to the pipes. The potential difference between the rails and the cable sheaths increases very rapidly with increasing distance from the power station, as is seen from Fig. 4.

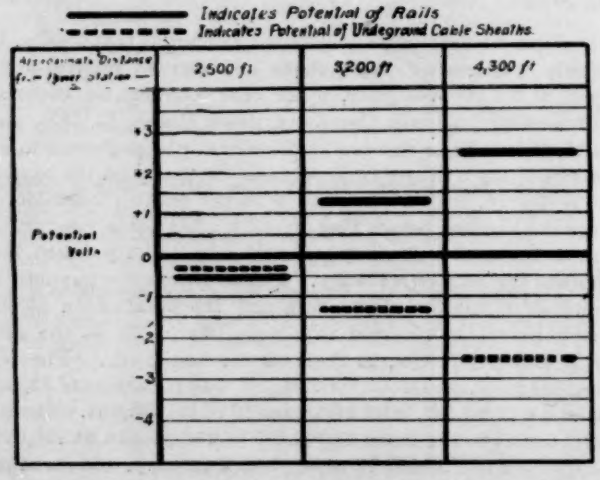


Fig. 4.—Diagram Showing Relative Potentials of Water Pipes, Trolley Rails and Underground Cable Sheath-Water Pipes Taken As the Datum or Zero Potential.

The next step in the survey is to measure drop between drip or service connections, which will indicate the probable existence and direction of current flow on the pipes. Such drop measurements cannot, however, be used for calculating the amount of current on the pipes. To determine the actual current flowing it is necessary to measure the drop between two points on a continuous length of pipe by means of a millivoltmeter. This drop, expressed in volts, divided by the assumed or measured resistance in ohms of the included length of pipe, gives the current expressed in amperes. A convenient table giving the current in amperes for 1 millivolt drop in 1 foot of standard wrought iron, steel and cast iron pipes is appended to this paper. To find the current flowing on a pipe corresponding to a given drop in millivolts for a measured length, multiply the amperes given in the table for 1 millivolt drop for 1 foot by the number of millivolts drop measured, and divide by the included length of pipe in feet. To measure this drop it is necessary to expose the pipe and to make good electrical contact between the millivoltmeter leads and the pipe. A satisfactory method is to use a pointed piece of steel, about the size of an ordinary lead pencil, fastened in a wooden handle, with a flexible connecting wire soldered to it inside of the latter. The pointed steel is then pressed against a bright spot or into a filled notch on the pipe. A still better contact is obtained by soldering the connecting wire directly to the pipe or to a brass plug screwed into the pipe, which is particularly advantageous when readings are to be taken over a considerable time. When such contact wires have been soldered to a continuous length of pipe it is common to use rubber covered wires, bringing them to the surface of the street, leaving the ends in drip or service boxes, which then form permanent test stations for electrical measurements. This is exceedingly convenient, for it is then possible to make current measurements on the pipe without again digging an excavation. Such permanent contact wires for electrical tests are illustrated in Fig. 5.

It should be noted that small potential differences, such as 0.1 millivolt or less, may be caused by local galvanic or thermal action. Where such small values are found in a test for drop on a pipe a careful investigation should, therefore, be made to ascertain whether the observed potential difference is actually drop due to current flow or is due to local causes. The writer has found that such local potential differences are a frequent source of error when such tests are made by persons who are not accustomed to making accurate electrical measurements.

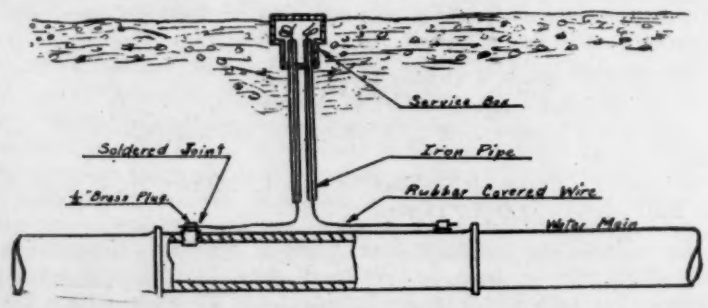


Fig. 5.—Permanent Electrical Test Wire Attached to Main and Brought to Surface of Street Through Service Box.

When drop measurements between services and current measurements on pipes have been generally made on a piping system, the results are conveniently plotted on a skeleton map of the city in which the pipe lines are shown and the current flowing on these pipes are indicated by arrows. A typical current survey map of a portion of a city is shown in Fig. 6. It is seen that here the currents on the pipes flow in a general direction towards the railway substation.

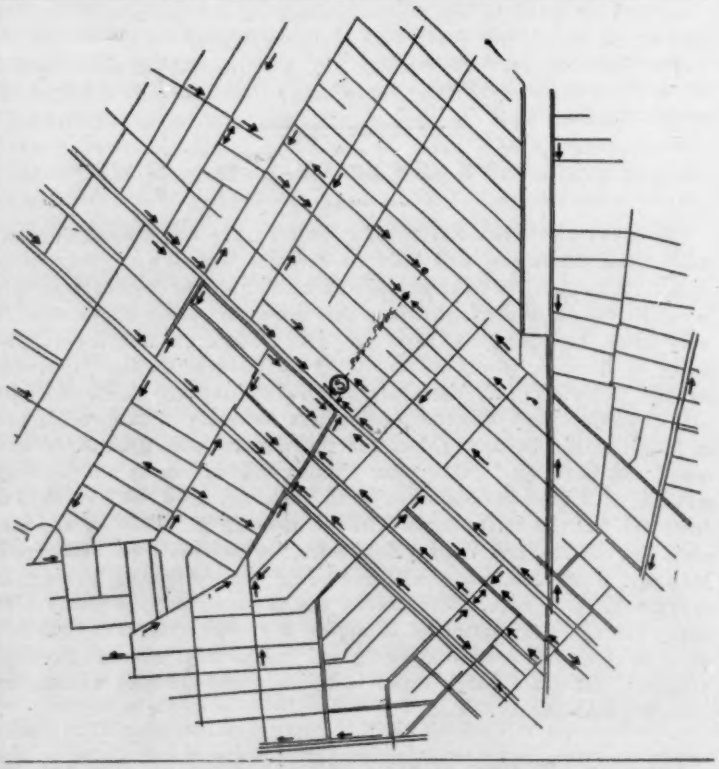


Fig. 6.—Typical Current Survey Plotted on Skeleton Map of Section of City Showing Underground Mains and Stray Currents Flowing on Mains.

Since current destroys the pipe only where it leaves the pipe for soil, it is important to know where the current does leave the pipe. Current measurements on pipes are, therefore, frequently made at two or more stations simultaneously in order to determine the change of current on the pipe between the stations. In Fig. 7 simultaneous current measurements made at two stations on a pipe are shown plotted where there is no change of current between the stations. In Fig. 8 simultaneous current measurements at two stations on a pipe where there is a considerable loss of current between the stations are likewise shown.

In order to determine the characteristic variations of a potential difference between pipe and rails, or of current flow on a pipe, 24-hour records of such potential difference (or of current flow) may be obtained by means of a special Bristol, smoked-chart, recording instrument. This recorder has for its measuring system a sensitive Western millivoltmeter, and may be provided with a number of ranges. It is convenient to have the instrument provided with its zero in the center of the scale, and with ranges of 5, 50 and 500 millivolts, and of 5 and 50 volts. Shunts of any desired ampere range can also be used in connection with the recording millivoltmeter, and the instrument used as a recording ammeter of a corresponding range. Convenient shunts for this are ordinary switchboard shunts adjusted for 50 millivolts drop, with rated capacities of 5, 50 and 500

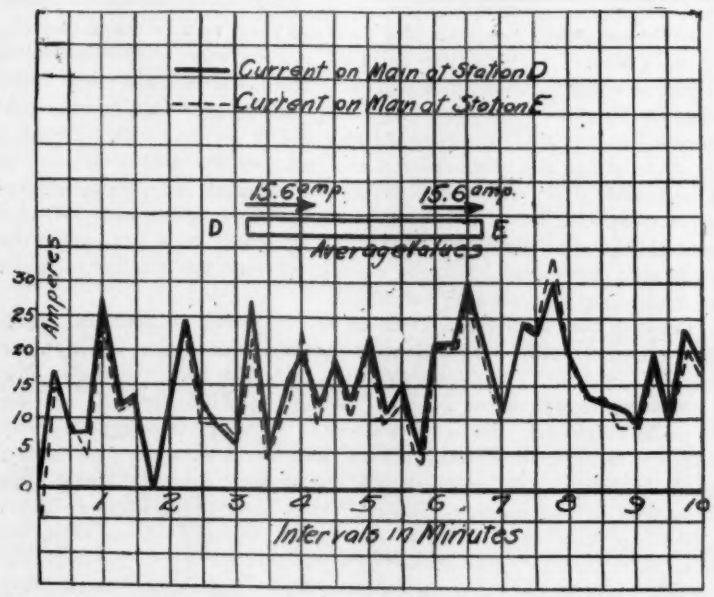


Fig. 7.—Simultaneous Currrent Measurements at Two Stations on Main Where There is No Change in Current Between Stations.

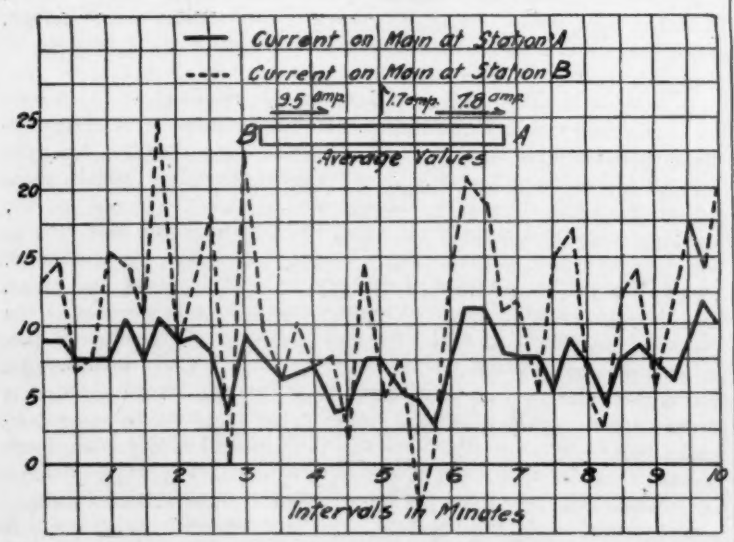


Fig. 8.—Simultaneous Current Measurements at Two Stations on Main Where There is Change in Current Between Stations

amperes. Such potential and current records are conveniently plotted from these charts in rectangular co-ordinates. Sample 24-hour records of current on a pipe plotted in rectangular co ordinates for one week are shown in Fig. 9, from which it will be seen that the

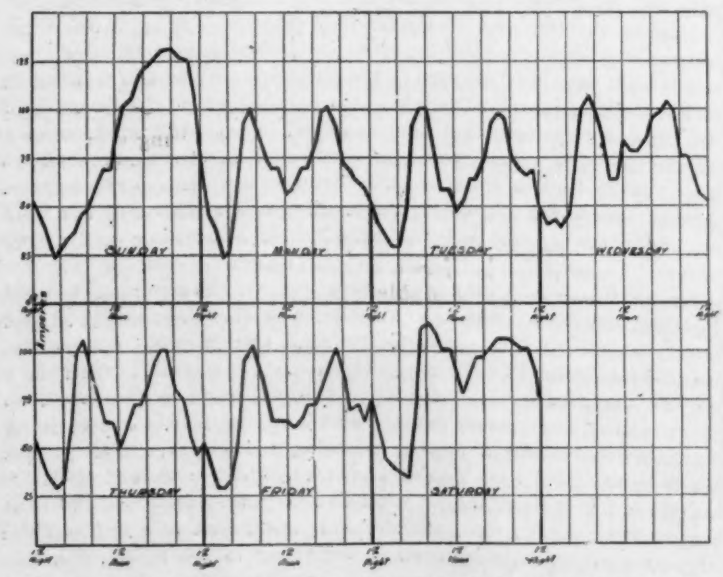


Fig. 9.—Stray Currents on Water Main Averaged from Bristol 24-Hour Records and Plotted for One Week.

current records for weekdays are practically alike, and show morning and early evening peaks. The record for Sunday is, however, very different and shows a very large peak throughout the whole afternoon. This is accounted for by the fact that the neighboring trolleys were carrying large crowds of excursionists on Sunday outings. By means of such 24-hour records it is often possible to positively identify the source of current flowing on a pipe as railway current from its similarity with the railway load curves. Twenty-four-hour records of current flowing on pipes may also be obtained at 2 or more stations simultaneously, and the change of current between the stations for the 24 hours determined.

It is possible to trace the path of current flow through ground by measuring potential differences between points in the ground. Where small potential differences are measured between two points in ground and iron rods are used as electrodes, entirely incorrect results may be obtained, because of possible differences in polarization voltages at the surfaces of the electrodes. To overcome this difficulty, a "non-polarizable electrode" was devised by Prof. Haber. This consists of a glass tube, with a porous cup cemented to one end, containing a saturated solution of zinc sulphate, and of a zinc rod dipping into the solution. A wire is brought out from this zinc rod through a cork in the top of the tube. To make contact to ground with this electrode the porous cup is pressed against the part of the ground at which the potential is to be measured, thus establishing contact between the ground and the zinc sulphate solution. This establishment of electrolytic contact between ground and the zinc sulphate solution eliminates polarization voltages. The polarization voltage between the zinc rod and the zinc sulphate solution, which is a definite known voltage, must be allowed for when using this electrode. It is also essential that, when this electrode is used, the potential measurements be made by means of zero methods, and not with indicating volt-meters, because of the very high contact resistance produced with this electrode.

It is often also desirable to measure directly the flow of current through ground, as between a pipe and rails, or between 2 pipes. This can be done by means of an earth ammeter, which was also devised by Prof. Haber. This consists of a wooden frame with 2 copper plates insulated from each other by a plate of mica or glass. Insulated copper wires are brought out from the 2 copper plates, and these wires are connected to an ammeter. To use the frame, the 2 copper plates are, first, coated with a paste made of copper sulphate and a 20 per cent. sulphuric acid solution. A wetted piece of parchment paper is then laid over the paste, and the remainder of the frame filled with soil from the excavation where the current flow through ground is to be measured. The frame is then buried in ground normal to the direction of the current flow to be measured, and the ammeter will indicate the current flow which is intercepted by the buried frame. The object of the copper sulphate paste on each plate is to equalize polarization potentials at the surfaces of the copper plates. This earth ammeter is also well suited for measuring current flow between pipe and ground. For this purpose the frame is buried in the ground 1 or 2 inches from and parallel to the pipe. Measurement of current flow from a pipe thus made can be used to form an estimate of the probable amount of electrolytic damage to the pipe, and, in cases where corrosion has taken place, this kind of test will often serve as evidence that the corrosion has been caused at least in part by stray currents leaving the pipe. By using a recording instrument in connection with the earth ammeter, the characteristic variations of the current leaving a pipe can also be determined, and in this way the identity of the current can often be established.

From a study of the results of the survey it can be determined where current is leaving the piping. At a number of such points excavations should then be made and the exposed pipe examined with a test hammer for electrolytic corrosion. Where such corrosion and pitting are found at points where current is found leaving the pipe, it may be taken as evidence that the destruction was caused by electrolysis, because it has been conclusively proven that current cannot leave iron for surrounding soil without producing corresponding destruction of the iron.

Regarding the use and value of an electrolysis survey, it must be remembered that the object of the survey is to indicate the existence or non-existence of stray electric currents upon a piping system, and to determine where such currents flow on to the pipes and from the pipes. I have had occasion to examine a large number of electrolysis surveys and have found that many of these consist exclusively of voltmeter readings, and often these voltmeter readings are only made with reference to the rails. Such readings by themselves do not afford a measure of electrolytic danger. Potential measurements should be made to all underground structures. Measurements of

current flow on pipes are also essential in an electrolysis survey because all current which flows on a pipe must leave it, and the amount of damage produced is proportional to the total current which leaves the pipe. I have seen some reports, on the other hand, where it is stated that the current on a given pipe is zero, but where the instruments and methods employed were not sufficiently sensitive to detect current as large as 2 or 3 amperes, and where, therefore, the conclusion of zero current is not warranted. From a complete and properly analyzed electrolysis survey, a great deal of good can generally be accomplished. It will not always be possible to remove all stray currents from the pipes, but measures will be indicated by which the conditions can be greatly improved, and points of greatest danger will be located. If then trouble does occur at a later time at these points, the electrolysis survey may be most valuable in affording proof of the destruction of the property from railway currents, and may be the means of compelling the railroad company not only to pay for the damage, but also to make improvements in its return system so as to avoid the recurrence of such damage. I know of a number of electric railroad companies who are regularly paying for damage caused by electrolysis to piping systems. The knowledge that a pipe-owning company is making electrolysis tests and is keeping watch on the situation, also has a strong moral effect on the electric railroads.

(To be Continued.)

Daylight and Artificial Lighting of Interiors.

[Abstract of Fourth Lecture of a Course Delivered by Mr. J. S. Dow, at the Polytechnic, Regent Street, London.]

Natural illumination receives comparatively little attention from the lighting engineer; yet it is obviously important, if only for the reason that by far the greater part of the day's work is usually carried on by daylight. There are certain buildings—museums, picture galleries, etc.—which are usually only lighted in this way, and there are certain trades(baking and printing for example) which are largely carried on in underground premises.

On hygienic grounds it is thoroughly recognized that the admission of daylight is most essential. Abundant natural light is one of the best preventatives against dirt and germs of disease, and the legislation of Holland, on the lighting of factories, prohibits women and children being at work in premises from which daylight is totally excluded. Again, when the Wesleyan Hall was being erected near the hospital in Westminster (London), the hospital obtained an injunction limiting the height of the proposed building on the ground that it might prove prejudicial to the health of patients.

From the purely utilitarian standpoint, also, it is generally considered to be easier to do work by day than by night time, although possibly this might not be so if artificial lighting were always scientifically designed. But the statistics compiled by the Fidelity and Casuality Company, of New York, show that the number of accidents occurring is greatest in the winter months when artificial light is most used, and this naturally suggests that the artificial lighting is not so good as daylight.

Many people, arguing in favor of some particular system of illumination, assume that daylight is necessarily the ideal; yet, as a matter of fact, daylight, besides differing materially from most artificial light, has also certain grave faults. The most striking respect in which it differs from artificial light is the intensity. In an ordinary office the daylight illumination may sometimes be as much as 100 times that prevalent in the evening by artificial light; in the street it may be actually 1,000 times as great. This high intensity seems to mask the enormous variations in daylight. Natural light varies with the time of day and the season of the year, and with special climatic conditions (fogs, mists, etc.), it is not subject to control like artificial light. Moreover the distribution of illumination in an ordinary room lighted by sidewindows is usually very uneven; variations occur such as would never be tolerated by artificial light. The actual amount of light reaching any point in the room again depends on many different factors; *e. g.*, the area of the windows and their position; the amount of obstruction outside the window due to trees, adjacent buildings, etc.; the shape and dimensions of the room; the lightness or otherwise of the walls and ceiling of the room, etc.

The English Building Acts in some case specify that the ratio of window space to floor area should not be more than 1.5. In addition the modern tendency in building schools and factories is to avoid deep rooms, some portions of which are very remote from the windows. Modern factories are built tall and narrow, with windows on either side and in the textile works in the Midlands, one story buildings with glass roofs are frequently employed. One of the most essntial points is to have the wall and ceiling light in tint. This aids in distributing the illumination and removes want of evenness to a great extent. It may be added that photometric tests are coming to be appreciated as an aid in deciding ancient light cases. By this means it is often possible to ascertain by actual tests how much the light will be reduced by the erection of an adjacent building instead of depending on a general judgment.

Turning next to general points to be considered in artificial lighting, the first matter that will come up for consideration is the choice of an illuminant. In this connection it should be pointed out how many are the factors besides cost that settle which form of lighting is to be employed. For example, some years ago two large railway stations in London, Charing Cross and Victoria, were considering their lighting and some comparative tests with flame arcs and high pressure gas were made at Charing Cross. As a result Charing Cross adopted electric and Victoria gas. Many other stations might be mentioned that are lighted partly by gas and partly by various systems of electricity, thus showing that neither method is invariably and exclusively the best. In a factory the kind of work to be carried on, the question whether electric power for driving is to be used, whether local-shaded lamps or general illumination are preferred, all these points will be instrumental in deciding the system to be adopted.

In considering the lighting of a room the essential point to consider is where the light is needed. In many cases it is desired to flood the room with an even illumination and every portion has to be lighted as well as any other. In other cases there are certain spots where the light should be concentrated. Thus, in goods' yards, packing rooms and many workshops, filled with people stationed at regular intervals, general illumination will often be preferred. When there is complicated machinery, or many shelves and racks, etc., so that the light is desired to penetrate into every corner of the room, indirect lighting will often be advisable. An instance of this is provided by printing works where the light should actually get *underneath* the machine; but when very fine and accurate work is to be done the workmen will be found to prefer a local light; watchmakers, jewellers, and engravers often use a light of this kind. Such lights should be completely shaded so that the mantle or filament is invisible to the eyes of the worker. In banks, again, local lights at each desk are usual, but the most modern premises supplement this by semi-indirect general illumination as well.

Another point to be considered is the possibility of only 1 section of a room being used for work at a time. When this is the case it is usually desirable to subdivide the lighting so as only to light the quarter where work is carried on. If the whole room is lighted from a single central source, on a single switch or cock, it will be necessary to light the whole room always, and this may mean waste.

In selecting the form of shades and reflectors in an interior one naturally had to consider how the light should be distributed, how much light should be allotted to the walls and ceiling and how much to the working plane. There are also cases in which the direction of the light is very important; for example, in tailoring work, when a rapidly moving cutting tool is used, and inconvenient shadows might easily lead to spoilt work or even an accident to the worker. Again, every one is aware how troublesome shadows of the head and body are apt to be in a badly lighted schoolroom or drawing office.

As an illustration of some general rules to be observed in good lighting, Mr. Dow threw on the screen a series of slides reproduced from "Light and Illumination; Their Use and Misuse," a recent reprint from the "Illuminating Engineer" (London), which is a slightly modified version of the publication issued by the American Illuminating Engineering Society with a similar title. In describing lighting installations it is now becoming usual to give photographs taken by artificial light and results of photometric tests of the illumination. The latter should include figures for the illumination at the working plane; also, the diversity coefficient (*i. e.*, ratio of the highest and lowest illumination occurring in the room), the surface brightness of surroundings and the consumption per square foot of gas or electricity.

As a result of figures recently presented before the Illuminating Engineering Society in London, the following general rules might perhaps be given:

System of Lighting.	Consumption per sq. Ft. of Floor Area.	Illumination, Foot-Candles.
Tungsten lamps and efficient reflectors.. (Holophane, steel reflectors, etc.)	0.5 watts.....	2 ft. candles.
Indirect tungsten lighting	.4to.7 watts.per sq.ft.	One 1.5 ft. candles.
Indirect arc lighting.	1 to 1½ watts per sq. ft.....	Four 6 ft. candles.
Gas lighting, low pressure.....	.015 to .05 cu. ft. per hour..	Two 5 ft.-candles.
Acetylene.....	.005 to .01 cu. ft.....	Three-quarter 1½ ft. candles.
Petrol air gas.....	1 gal. petrol per hour, gives about 20,000 lumens.	

These figures, of course, constitute a very rough guide and only apply to cases in which it is desired to illuminate a considerable area evenly all over. The results must always be affected by the question, "How much light is concentrated downwards and how much on the walls and ceilings?" And this will depend on individual requirements. The figures for acetylene and petrol air gas in particular should only be taken as very approximate and require further confirmation.

Gas Light in the Manufacturing Plant.

[By Mr. Warfield Webb.]

An important factor for the indoor, more particularly the factory worker, is the question of light. It is conceded that natural light is the most beneficial, yet there are many plants that are insufficiently lighted from lack of windows; and, even then, in the short working days, there are hours that demand some sort of artificial lighting service in order to make possible a full day's work. It is a difficult matter to so arrange a factory that it will have ample natural light, even during the greater part of the day, owing to the size of the working rooms.

Then there are other conditions that arise, owing to the nature of the labor, and this has a special application to plants devoted to work that necessitates constant use of the eyes. In tailoring plants, factories for the manufacture of women's wear, or for the manufacture of cloth materals, shoes, and many of the delicate materials and commodities that necessitate care and constant eyestrain. Even in such factories as are given to some of the less exacting labors, on the part of the worker there is a strong need for such light, natural or artificial, as will lessen the danger to the eye, the most delicate organ of the human body.

In the past very much was written on this topic; but the more exacting conditions in the industrial world to-day make it of more importance than in the past. Scientific men and physicians, having given this question particular study, have arrived at the conclusion that where it is not possible to have ample natural light there must be artificial light that will lessen the strain upon the eye, thus obviating any serious injury to the organ. It is well understood that it is not the brightness of the light as a factor for making this condition a realization, so much as a soft diffusion of the light that will attain the end so earnestly sought.

An authority on the subject had this to say regarding the importance of the question: "The effect of pathogenic illumination in factories, workrooms, schools, etc., is a puzzling one to many investigators. They do not know what to do with the question, and the effects, if any do exist, of bad lighting are noted with peculiar vagueness, the recommendations being still more vague." He further states it has been proven that using the eyes under bad conditions causes eye fatigue and that probably 80 or 90 per cent. of headaches is chargeable to eye strain.

The reasons assigned by this conclusion are brought about because of dirty, unpainted, overheated rooms, with impure air and excessive moisture for 10 hours per day, or even for the last 2 hours during the 24 hours. There is used up a considerable amount of nervous energy, and as a consequence there follows eye strain or eye fatigue, with graver consequences. The real issue as seen is the poor illumination. This is augmented by lack of the means to permit the admittance of natural light; few windows, or windows that are dirty; rain, fog, early and late hours during each day. The smoke nuisance adds its weight, and poor artificial illumination has much to do with the real trouble.

If the manufacturers seek to exclude the natural light for any reason, as is sometimes done, there should be a much greater consideration given the question of artificial light. Some of the factories are being moved to the outlying districts of our cities, and even in smaller places, but there is demanded in these locations at some hours a means of lighting the plant by artificial methods. It is only after all the question of how to light these plants so as to make them less injurious to the workers. If we can combine economy in lighting, and still reduce the danger from eye strain, then we have arrived at the solution of a most necessary problem.

To-day there are a large number of illuminants on the market. The day of the candle, and to a great extent the lamp, has disappeared. The more recent inventions in connection with gas light have made possible ideal conditions, and it should be noted that there has been a like increase in the use of the gas light for industrial workers' use. The invention of the gas mantle made this possible to a marvelous degree, and the continued improvements in this direction have done a great deal to further the industry. Also, there has been a satisfaction noted by the users of this kind of lighting service that makes the matter one of still greater importance to the working public.

The inverted gas arc light, with a capacity of 350-candle power, for 300 feet of space, the cost of operation which is less than 1 cent per hour for gas, has done much to improve these factory conditions. Constructed with an enamel reflector, it thus increases the power for light, while still diffusing only a soft, mellow ray the least injurious to the eye of the worker.

In some kinds of lighting systems, and this has application to the electric light, there has been noted far too much brilliancy or stare. This acts as a direct injury to the eye and counteracts the good that is sought thereby. We cannot look straight at a bright light and not feel almost instantly the evil effects upon the eye. Even if it is only moderately brilliant, there will shortly be noted a feeling of weariness to the eye that is sure to be bad in time. It is not frequent that we are compelled to gaze directly into the light itself, but this is stated merely to prove just what the effects of the light are upon the eye. The reflection of the brilliant rays is sure to be detrimental, and the constant use of the light that has an injurious effect upon the sight will sooner or later be noted.

There is, in addition to the restful effects upon the eye of the modern gas light, a hygienic condition that will be most beneficial to the worker in the congested factory. It has been noted that in many of these the hygienic conditions are bad. The air is many times foul, and the sanitary condition of the plant, where there are many people gathered together, is sure to be detrimental to health. In this way there will come the improved conditions that the gas light will make, since the flame will add its weight in consuming these particles of foulness, and in assisting the purification of the germ-laden atmosphere. This, in itself, is a factor that should bear weight with the manufacturers who are considering the welfare of their employees.

Here, then, we can combine low cost of operation, satisfaction in lighting, and an improved hygienic condition in the plant itself. It is not possible to do more than this, and, in at least some respects, there is noted here only a slight difference from the admittance of the natural light itself. The modern idea in all kinds of working plants is to conserve the health of the employees. It is now considered a vital question, and as one that brings with it a far better class of workers, making possible a great amount of actual accomplishment on the part of the latter.

The thing most desired by the manufacturer is results. If the conditions of the plant are such as to make this possible there will be a like return, and the workers will prove a source of real profit to such organizations. If there is possible a greater amount of labor each day with lighting conditions made favorable there can be no possible opposition on the part of the proprietors to installing such a system as will bring this condition about. It has been proven. Tests have been frequent enough to make this more than a theory, and there remains but the activity on the part of the gas companies to instill this idea into the heads of the willing public, with a profitable return to themselves.

The proprietors of the Berwick (Pa.) Gas Company have applied to the authorities of the outlying settlement of Nescopeck, for the right to pipe the streets of the named place for a gas supply thereto and therein.

The Exactograph Meter Slip as an Aid to Creating Public Confidence.

[Communicated by MR. C. A. KOLSTAD, Elmira, N. Y.]

The gas, electric or water company that is giving its consumer an opportunity to properly check the meter when it is read, leaving with him a fac-simile of the dials, is taking a long step in the direction of creating public confidence. The leaving of a slip, such as the Exactograph Slip, will help considerably in teaching the consumers to read their meters, for when the consumer compares the exactograph slip with the dials on the meter, and finds the reading to be correct, it will in many instances save a trip to the office and the investigation of a complaint.

The situation here in Elmira is rather unique, the artificial and natural gas, electricity and water being supplied to the public by one company. Up to a short time it was the custom here to have separate men read the various meters on the consumer's premises. Now, we have only one man calling, who reads all meters at one time, and within 48 hours one collector delivers all the bills covering the consumptions shown.

We use the exactograph meter slip for registering the reading, and, in the event of the consumer not being at home, the meter reader leaves a postal card. This postal card reduces our pick-ups to a minimum, as quite a number of consumers read their own meters and we find in most instances that the readings as turned in check up fairly accurate. This, of course, can be ascertained by comparing previous periods.

Paragraph 389, Chapter 825, Laws of 1911, reads: "No person, firm or corporation, delivering coal, coke or charcoal, shall deliver, or cause to be delivered, any quantity or quantities of coal, coke or charcoal without such delivery be accompanied by a delivery ticket and duplicate thereof, on each of which shall be in ink or other indelible substance distinctly expressed in pounds the quantity or quantities of coal, coke or charcoal contained in the cart or wagon or other vehicle used in such delivery, with the name of the purchaser thereon, and the name of the dealer from whom purchased. One of such tickets shall be delivered to the person specified thereon, and the other of such tickets shall be retained by the seller."

Paragraph 389, Chapter 825, Laws 1911, reads: "A violator of any of the preceding section shall be guilty of a misdemeanor, and shall, upon conviction, be liable to a fine of not over $50 for the first offense, and not over $100, or 2 months' imprisonment, or both, for the second and each subsequent offense."

If it is necessary to give a duplicate slip showing that the purchaser is receiving a certain quantity of coal or coke, why wouldn't it be good policy to let your consumers know the reading of their meters, when the reading is taken. If the consumers save their slips, they are then able to c mpute their bill before the same is rendered, and, if the bill seems excessive, have an opportunity of checking up the reading, and if found incorrect notify the Company, and thus rectify a mistake before, rather than after, the bill is made out.

In some localities, the public service companies are compelled by local ordinances to leave a reading of the meter with their consumers. Where this is necessary it appeals to the writer that the Exactograph is the ideal slip, as it makes it impossible for the meter reader to leave with the consumer a different reading than that which is turned in to the office; the duplicate being a carbon copy of the original.

There is also another advantage to this system, that of advertising. The back of the slip which is left for the consumer can be utilized at a very small expense for advertising the company's wares.

The duplicate slip left with the consumer is not only a good thing for the consumer, but it is also a protection to the company. The meter reader having no previous reading to go by, is compelled to take an absolute reading. He cannot sit at home, or some other place and read the meters, because he has no previous readings to go by.

I have had numerous inquiries in reference to this system and it now has been adopted by several companies, and I am led to believe that it is being looked upon as favorable. The American Sales' Book Company, of Elmira, N. Y., print these slips in very large quantities, and will be glad to correspond with anyone that might be interested.

It is certain that corporations like ourselves, dealing in commodities that are more or less under public discussion, and subject to regulation, should do everything in their power to let the public see that they are being treated fairly. Nothing else establishes this confidence so much as a written record which the consumer can study and compare. The Exactograph slip given to the consumer tends to dispel suspicion and create confidence.

Items of Interest
FROM VARIOUS LOCALITIES.

A CORRESPONDENT in Bristol, R. I., writing under date of the 8th inst., says that the 66th annual meeting of the shareholders in the Providence Gas Company was held in its Market Square office the 7th inst. The attendance was gratifyingly large, and the annual report (which narrated in detail the Company's operations for the year) was of the most gratifying nature. The report was the first item for consideration, and amongst its recapitulations these may be cited:

"The new coal gas plant at Sassafras Point has been operated to the full capacity of the present installation, and a contract has been made for an additional stack of 6 benches of vertical retorts, and this is expected to be in operation about September 1, 1913. This will make an increase of 50 per cent. in the amount of coal gas made at this plant.

"The exclusive franchise with the city of Providence, which had been in operation for 20 years, expired August 3, 1912, and your Directors have not thought it advisable to make a new franchise of this character. It is believed that the amount of money paid to the city of Providence, on account of this franchise tax, should be paid directly to its consumers, and this was considered when the price was reduced 5 cents per 1,000 cubic feet on October 1, 1912.

"Your Directors, after much consideration, decided that the erection of an office building, located in the business section of the city, for the use of the Gas Company only, on the lot at 85 to 89 Westminster street, extending through to Exchange place, and purchased some two years ago, be abandoned. Your directors decided that it would be for the interests of the Company to rent quarters for the administration, executive and revenue offices, and so have made a lease, for 10 years, for sixth and seventh floors in the new Turk's Head building, with a small office in the westerly end on Weybosset street, to be used for the collection of payments, for applications, complaints, orders and other matters requiring information or attention by our customers. It is thought that sufficient room has been obtained for not only the present but the future needs of the Company. It is expected that these new quarters will be ready by June 1 of the present year." The stockholders, having ratified the report, re-elected the following Board of Directors: Henry D. Sharpe, John W. Ellis, Wm. L. Hodgman, Webster Knight, Frank W. Matteson, John B. Branch, Newton D. Arnold, John R. Freeman, and C. B. Brown. The Board then perfected the following executive management: President and General Manager, Jno. W. Ellis; Vice-President, Henry D. Sharpe; Treasurer, C. H. Manchester; Secretary and Assistant Treasurer, Arthur F. Short.

THE engagement of Miss Mary Reddy, daughter of Mrs. James M. Reddy, 3913 Grand boulevard, Chicago, to Mr. Paul Doty, General Manager of the St. Paul (Minn.) Gas Light Company, is announced. The ceremony will take place in the home of the bride, the 8th prox. The celebrant will be Bishop J. J. Lawler, of St. Paul. The bride-to-be is a daughter of the late James Reddy, of Chicago, and a niece of Edward Cudahy, of Chicago. That they have the best wishes of all gas men goes without saying.

THE Gas Machinery Company, of Cleveland, O., has been awarded the contract for a complete, new water gas plant at Paris, Tex., consisting generally of 2 double superheater, carbureted water gas sets, boilers, steam piping, oil storage tank, exhausters, tar extractor, tar and liquor separator, purifiers, meter, gas connections, and miscellaneous parts. The Gas Company will construct new buildings to house the machinery. As it is also on the cards to add to the storage capacity, the Company, after some moons, will be the proprietors of an altogether new works.

GENERAL MANAGER MIDDLETON, of the Georgetown (D. C.) Gas Light Company, seems to have at last convinced his proprietors that gas can be made, at a price on their own works, to yield about as good returns, if not better, than if they were purchasing a good portion of their sendout from other parties. At any rate it has been determined to expend $30,000, or more, on plant extensions, these to include: A 6-foot 6-inch set of water gas apparatus; a new generator house, of steel and concrete construction; suitable enlargement of inlets and outlets to the two relief holders; new boilers, and an additional purifying box. This expenditure has been made possible by close attention to details of management, the careful administration

of which has added largely to the money earning capacity of the plant. Since the advent of Mr. Holden to the engineering charge of the plant the "help" around it is not swelling so much with pride, nor is it so well burdened with laziness as in the days of the near past. Common sense business methods have been developed and are being used by the engineering and executive forces of the Company, the general proprietors of which will soon experience a change as between the returns that were and those that are.

A FURTHER mention respecting the current annual meeting of the Providence (R. I.) Gas Company comes to us in the instance of the following interesting figures: The gas made in the twelvemonth totaled 1,561,128,000 cubic feet, which is thus accounted for: Sold, as per consumers' meters, 1,470,599,700; unaccounted-for, 74,770,900 cubic feet, or less than 5 per cent. In the manufacture of the quantity of gas these quantities of materials were used: Gas coal, 63,196 gross tons; anthracite, 13,467 gross tons; coke, 936 tons; gas oil, 3,921,253 gallons. These quantities of residuals were sold: Coke, 28,264 tons; coal tar, 955,973 gallons; ammonia, 432,172 pounds. The main pipe added to the distributing division amounted to 24.8 miles; new services laidin, 2,177; services relaid, 782; number of meters in use, January 1, 1913, 50,366; meters set, 17,577; meters removed, 14,860; increase, 2,717.

"L. R. V.," writing from Lynn, Mass., under date of the 7th inst., says: "The practical application of the device known as the pulmotor was demonstrated one evening this week, by City Physician and Associate Medical Examiner, Dr. Joseph O'Shea, in the Record Room of the Lynn (Mass.) Gas and Electric Company. Dr. O'Shea was introduced by Mr. W. H. Mace, of the Lynn Company, and he was greeted by an audience that actually overflowed into the hall. Those in attendance were most of the employees of the Company, as well as prominent engineers of the General Electric Company, many physicians, several men prominent in the civic affairs of Lynn, and a number of the General Electric's rank-and-file. The Doctor's initiative was a scholarly and interesting short lecture on the circulation of the blood and in connection therewith the functions of the several breathing organs. With the oral speech was a demonstration with the heart and lungs of a recently killed animal. The course of the blood as it flowed through the body, the necessary requirements for the normal operation of the organs, supplemented by a recounting of the happenings to the organs of various accidents, were narrated by the Doctor in terms that enabled 95 per cent. of his hearers to follow the narration intelligently. The Doctor testified to the value of the pulmotor in cases of drowning, ordinary and extraordinary asphyxiations, fainting spells and pneumonia; also, the functions of the device in respect of its varying applications. Following the lecture, the Doctor gave a practical demonstration of how the device should be applied and used. As these particulars are, of course, known to nine-tenths of your readers, their repetition here seems unnecessary.."

THE Hanover (Pa.) Gas Company is no more; that is, in name. And it is a question whether the new title is better than the old one. In any event its patronymic for the present is the Conewago Gas Company.

MR. L. L. CADWALLADER, formerly in charge of the gas plant at Roanoke, Va., has actively assumed charge of his new post, that of Superintendent to the Chambersburg Gas Company.

"M. M. S.," writing from Lebanon, Pa., under date of the 7th inst., send us this: "What promises to be one of the best things yet done by the managers of the Lebanon (Pa.) Gas and Fuel Company, is to be the gas appliance exhibition, set for the 17th, 18th and 19th of next month. The displays, demonstrations and other features will be given the afternoons and evenings of the named days. Mr. George S. Speaker, the wideawake Manager of the Corporation, has secured the services of Mrs. A. A. Carroll, formerly of the staff of the U. G. I. Company, who will be assisted by a number of women quite competent to take part in such an affair; and each day, amongst the other novelties put forth, will be the preparation of a 6-course dinner, and the cooking thereof, the viands to be sampled or consumed by those in attendance whose appetite and inclination lead them to the table. Ample provision for displaying the industrial uses of gas have also been made. These evidences will include water heating, riveting, etc. There will be music during the afternoons and evenings. New and unique souvenirs will be distributed; and there will be a coupon competition in which the holder of the fortunate number will be awarded a useful gift. The Company figures that, as there will be no business men's show in Lebanon this spring, the gas show must be a positive success."

THE third annual supper of the employees of the Westchester Lighting Company, Yonkers district, was held the night of Saturday, March 8th, at the Broadway House, South Broadway and New Main street. About 50 were present, and music, mirth, stories and speeches contributed to a pleasent evening. The supper served by Mine Host Casper Will was highly praised, and a rising vote of thanks was tendered him. Max F. Landsberg acted as toastmaster. He first called on Charles Otten, Jr., the Superintendent, whose well-sounding speech was followed by another clever talk from Mr. E. O. Baxter, Chief Clerk of the district. Several other speakers also told in one way or another how glad they were to be there. Some good vocal music was enjoyed, the chief contributors to this part of the entertainment being the Van Wart Brothers, Arthur Keefe, J. Conley, P. Kinehan and J. J. Baker.

THE Mead-Morrison Manufacturing Company, of Boston, a concern well-known to the gas industry of this country, has purchased a 10-acre tract of land along the line of the B. & A. Railroad, in East Boston, whereon it has arranged to erect a manufacturing plant of a character adequate to cope with its fast growing business, the scope of which is now well beyond the resources of its present shops in Cambridge. The machine shops which it is planned to construct will likely be the largest of their kind in the United States. These will comprise a plate shop, erection, machine and pattern shops, a power plant, foundries and general offices. Contracts have already been awarded on these accounts: To the McClintic-Marshall Construction Company, of Pittsburgh, Pa., for the machine and erection shops; to the Levering & Garrigues Co., of Dunnellen, N. J., for the plate shop; to the New England Foundation Company, for the foundations, and to the Shaw Electric Company, for the electric cranes. The shops will be equipped with one 25-ton and four 10-ton cranes. The Mead Morrison concern makes a specialty of coal handling machinery and of steam and electric hoists, and contracts to erect and equip the largest docks for the handling of coal, not in the United States alone, but abroad. Orders are at present on its books equal to a year's output from the factories, and the new plant will require for its operation the services of 1,000 men. The executive management of the corporation is thus composed: President, Gov. Eugene N. Foss; Vice-President and General Manager, Willard S. Martin; Treasurer, John G. Morrison; Assistant Treasurer, Burton L. Gale.

THE Consolidated Gas, Electric Light and Power Company, of Baltimore, Md., in its bid to the authorities for the supply of gas to the public buildings and the street lamp posts, offered these figures: For the former 75 cents per 1,000; for the latter 67½ cents. This is a concession from last year's figures of 5 cents and 2½ cents per 1,000, respectively.

MR. ALBERT A. SHEPHERD, after many years of good work in the meter and complaint division of the City Gas and Electric Divisions of the Municipal service of Holyoke, Mass., has resigned.

Recent Patent Issues.

Prepared for the AMERICAN GAS LIGHT JOURNAL by ROYAL E. BURNHAM, solicitor of patents and counselor in patent causes, 833 Bond Building, Washington, D. C., from whom illustrations and specifications of any patent mentioned below may be obtained for 20 cents.

1,054,719. Automatic Gas Lighting Apparatus. P. R. Seamon, Boston, Mass., assignor, by mesne assignments, to Automatic Lighting Company, same place.

1,054,720. Recording Mechanism for Meters. S. C. Shaffner, Chicago, Ills.

1,054,948. Proportional Fluid Meter. W. H. Symons, San Diego, Cal.

1,055,060. Gas Cock. T. J. Litle, Jr., Woodbury, N. J., assignor to Welsbach Light Company, Gloucester City, N. J.

1,055,203. Apparatus for Separating Water from Gas. H. McConnell Wilmington, Del., assignor of one-half to S. J. Newman, same place.

The Market for Gas Securities.

The city gas share market shows no appreciable change, although the tone to the quotations is considerably under than over high C. However, actual sales are few, and the daring ones for the short side are also few. Having been frequently searched in the past the bears are inclined to save their pelts from further singing. The opening prices to-day (noon, Friday), were 130¾ to 133. The technical position of the Company constantly improves. Every detail repecting the working harmony of the management dovetails after the style of the best joined work.

Brooklyn Union, too, remains unchanged as to quotations, although surface indications do point towards lower quotations. However, there is every practical reason for asserting that the reverse should be the case. Peoples, of Chicago, is weaker, despite the fact that the dividend rate remains unchanged. The dividend of 2 per cent. for the last quarter on U. G. I. shares is payable April 15th.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

115 BROADWAY, NEW YORK CITY.

MARCH 17.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked*
Consolidated Gas Co.	$99,816,500	100	130¼	133
Central Union Gas Co. —				
1st 5's, due 1927, J. & J.	8 5 0,000	1,000	103	105
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	105	106
Mutual Gas Co.	2,500,000	100	172	177
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	101	102½
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	59	62
1st Mtg. Gold Bds. 5 p. ct.	1,500,000	—	98½	100½
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	103	105
Con. 5's, due 1945, J. & J.	1,500,000	—	96	100
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	99½	101
Standard	5,000,000	100	60	70
Preferred	5,000,000	100	90	100
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	103	105
The Brooklyn Union	15,000,000	1,000	130	133
1st Con. 5's, due 1948, M. & N.	15,000,000	—	105¾	107
Yonkers	299,650	500	120	—
Out-of-Town Companies.				
Bay State	50,000,000	50	¼	5-16
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	—
" 1st Mtg. 5's	500,000	1,000	97	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
Bonds, 5's	5,250,000	1,000	59	60
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,000,000	1,000	104	106¼
Cincinnati Gas and Electric Co.	29,500,000	100	87	90
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	96	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	90¼	91
Preferred	3,036,500	100	75¼	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	13,460,084		118¾	119
Mortgages, 5's	3,400,000	—		—
General Mortgage 4½	10,661,000	—		—
Con. Gas Co., Baltimore City, 4½	2,751,000	—		—
Consolidated Gas Co. of N. J.	1,000,000	100	15	—
Con. Mtg. 5's	976,000	1,000	94	96
Bonds	75,000	—	—	100
Detroit City Gas Co.	6,580,000	—	—	50
Detroit Gas Co., 5's	381,000	1,000	75	80
" Prior Lien 5's	5,619,000	1,000	97	100½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	133	136
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co., 1st Mtg. 5's	1,350,000	1,000	100	101
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	130	133
" Bonds, 5's	10,500,000	—	104	106
Indianapolis	2,000,000	—	38	45
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	200,000	1,000	91	
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	86
Bonds, 1st 5's	3,822,000	1,000	98½	99
Laclede Gas Co., St. Louis.	10,000,000	100	100	100½
Preferred	2,500,005	100	99	102
Bonds	10,000,000	1,000	102½	103
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	120	130
Madison Gas and Electric Co.				
" 1st Mtg. 6's	400,000	1,000	106	
Massachusetts Gas Companies, of Boston	25,000,000	100	88	88¼
Preferred	25,000,000	100	93¼	94
Montreal L. H. & P., Canada	2,000,000	100	235½	236
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	97	98
Bonds, 6's	6,000,000	—	127	128
New Haven Gas Co.	5,000,000	25	188	190
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	110	112
1st Mortgage	20,100,000	1,000	102	103½
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104¾	105½
Pacific Gas and Electric Co.	15,500,000	—	58½	60
St. Joseph Gas Co.—				
1st Mtg. 5's	1,000,000	1,000	96	98
St. Paul Gas Light Co.	2,500,000	100	—	—
1st Mortgages, 6's	650,000	1,000	104	105
Extension, 6's	600,000	1,000	113¾	115
General Mortgage, 5's	3,447,000	1,000	94	96
Syracuse Gas Co., N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	101	103
Washington (D. C.) Gas Co.	1,600,000	200	427½	428
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,000,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	50	—	—

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